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HOMEOSTATIC UTILITY CONTROLS
APPLIED TO TVA

FINAL PROJECT REPORT

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CHAPTER 1

PROBLEM STATEMENT

The notion of Homeostatic Controls is named from the word homeosis, of greek origin, and which means "in equilibrium". In fact what is referred to in the context of this project is a novel way for a utility to actually interact with a growing number of its customers to achieve a better equilibrium between its peak and valley demand situations. The customers in question are those who have some degrees of freedom as far as their load schedules, seen from the utility, are concerned. Some of the fundamental aspects behind this project are:

- A number of customers have some lattitude as to how they schedule their demand as seen from the utility. They may have some freedom as to when they actually schedule their loads (shiftable loads), they may have some amount of on-site generation capacity, they may have some amount of on-site energy storage capacity. Using these various features, such a customer, here referred to as a Small Power Producing Facility, SPPF, may shift its demand during the day or may even turn out to be selling energy back to the utility during parts of the day. Clearly, the utility must come up with incentives for the customer to behave such that the SPPF actually "helps" the utility load curve; these incentives are the various energy rates.

- The National Energy Act, NEA, and more specifically the PURPA regulation, promulgated under the NEA, stipulates that the electric utilities must purchase any excess energy from its customers at a fair market price. This will probably result in a situation where the utilities will set so-called "spot prices" for the energy rates for the energy it sells to the SPPF and for the energy it purchases from the SPPF. These spot prices can be expected to vary rapidly with time to reflect the change in energy generation costs to the utility itself.

- The next logical step then is that these spot prices be communicated to the individual SPPF's for each upcoming time interval, say one hour, over the next 24 hours, for example.

The fundamental question then arises as to how a particular SPPF, having some degree of freedom as to its internal energy dispatching, will react to a set of selling and buying prices, communicated from the utility, when it carries out an optimization of its own operation. The individual SPPF scheduling optimization simulation problem is the cornerstone of this project. Three other and related problems were also addressed as outgrowths of the SPPF scheduling problem.

Another problem is that of dimensioning, during the plant design stages, the size of some of the on-site SPPF facilities, such as the on-site energy storage capacity. This can be done once the energy selling and buying rates are set. These design oriented problems are of importance when a utility, such as TVA, advises its customers as to what type and size of on-site installations are financially feasible. This problem is also addressed in this project.

The only true "control" that the utility has over the SPPF is through the selling and buying energy rates it communicates to the SPPF. Once these rates are communicated to the SPPF, the SPPF will react on its own to optimize its internal operation to minimize its costs or maximize its revenues. It is therefore of key importance to be able to determine a set of selling and buying energy rates which, while still within limits set by the local regulating agency, "induce" the proper behavior into the SPPF to satisfy the utility desired constraints. This pricing related problem has also been addressed within this project.

Finally, the global impact of all SPPF's on the utility system is also evaluated in the scope of this project.

The major outputs of this project are four computer programs to handle each of the four major topics outlined above. All four programs heavily rely on the Linear Programming optimization concept, incorporating a detailed mathematical model of each SPPF and a detailed mathematical description of the economical objective function to be optimized.

Chapter 2 provides a functional description of the model used for each SPPF.

Chapter 3 provides a functional description of the various optimization problems addressed within this project.

Chapter 4 provides a detailed mathematical description of the optimization algorithms used in the project.

Chapter 5 provides a description of the four computer programs developed.

Chapter 6 provides a set of illustrative computational results which help to describe the capabilities of the various programs developed.

Chapter 7 provides a complete system wide study applied to the TVA situation forecasted for an August Wednesday of 1990.

CHAPTER 2

SMALL POWER PRODUCING FACILITY MODEL

2.1 GENERAL FACILITY CAPABILITIES

The general layout for a Small Power Producing Facility is shown in Figure 1.

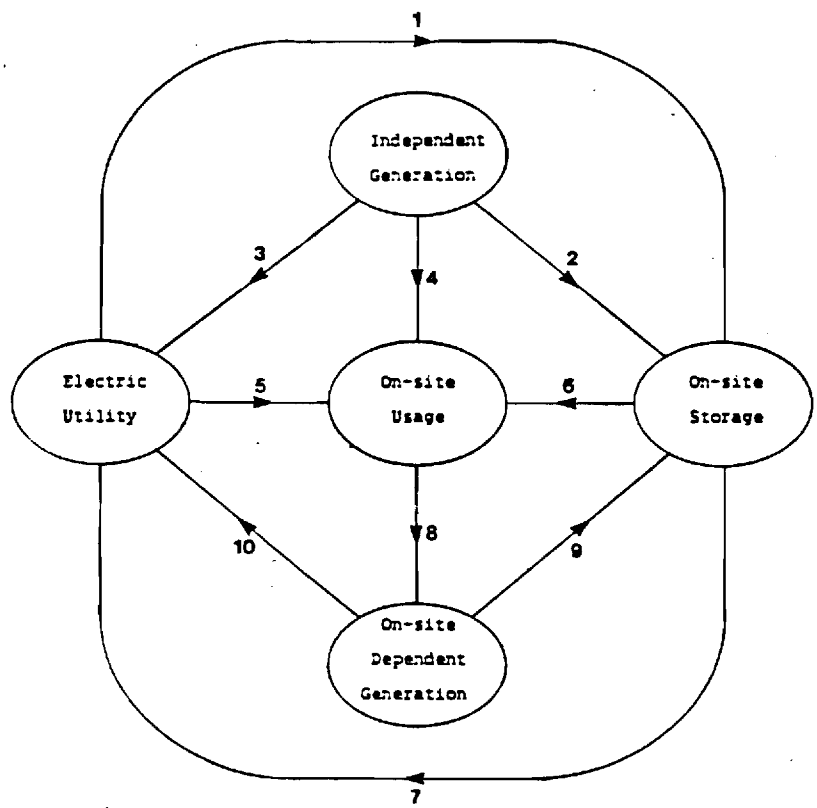


Fig. 1 - Feasible Energy Flows

A few comments are appropriate at this time:

- The electric utility energy can be used to cover the on-site usage and/or to increase the on-site energy storage (if the facility has such a storage facility installed).

- The on-site independent generation can be used to sell energy back to the electric utility, and/or to cover the on-site usage, and/or to increase the on-site energy storage (if the facility has such a storage facility installed).

- The on-site dependent generation feature is provided to facilitate the the modeling of cogenerators which are assumed to have an output level which is dependent on the level of the on-site usage. The dependent generation can be used to sell energy back to the electric utility, and/or to increase the on-site energy storage (if the facility has such a storage facility installed).

- The on-site energy storage can be increased using energy purchased from the electric utility, and/or using energy from the on-site independent generation, and/or using energy from the on-site dependent generation. The on-site energy storage can be used to cover the on-site usage, and/or to sell energy back to the electric utility.

- The on-site usage can be covered by purchasing energy from the electric utility, and/or by using the on-site dependent generation, and/or by retrieving energy from the on-site energy storage.

- It should be noted that the model does not allow energy produced from the dependent generation to be used back to cover the on-site usage.

2.2 EFFICIENCY CONSIDERATIONS

The proposed model does contain several efficiency coefficients to provide for the various losses in the actual system:

- The two lines between the electric utility and the on-site storage facility, i.e. lines 1 and 7 in Figure 1., have user-selectable efficiencies attached to them to take actual losses into account.

- The three lines between the electric utility and the on-site usage, the on-site independent generation, and the on-site dependent generation, i.e. lines 5, 3, and 10 in Figure 1., have user-selectable efficiencies attached to them to take actual losses into account.

- The on-site storage device itself has a user-selectable efficiency attached to it to take energy depletion in the device iself into account.

- The dependent generation output is made dependent on the on-site usage level using a user-selectable proportionality coefficient. If desired, this proportionality coefficient can be made to change with time.

2.3 ON-SITE DEMAND MODEL

The on-site usage, or demand, can be modeled in two fundamentally different ways:

- As a fixed load schedule where the demand is imposed by the user for each time interval over the entire simulation period.

- As a shiftable load where only the minimum and maximum usage level during any time interval are set by the user along with the total enery demand over the entire simulation period. This latter mode provides for the full simulation of SPPF's where some flexibility exists as far as their scheduling is concerned. As will be discussed later, several of the load parameters can be optimized as well for these types of loads.

2.4 ON-SITE GENERATION MODELS

The on-site generation can be modeled in a number of ways using two different models:

- The so-called independent generation which does not depend on the level of the on-site usage during each time interval. This type of generation is only specified by the user by the maximum output level during each time interval. The independent generation feature is to be used where the electrical output level can be fully controlled by the plant controller.

- The so-called dependent generation which is linearly tied to the on-site usage, using the BETA coefficient, during each time interval. This feature is useful to provide additional modeling flexibilty and can only be realistically used for shiftable loads where the detailed load schedule is to be determined by the optimization procedure.

It is important to note that both generation models may coexist for any particular SPPF.

2.5 MODEL FLEXIBILITY

It is important to note that the model shown in Figure 1 only gives the maximum, full, SPPF configuration. Not all features must be present for each SPPF. Indeed:

- The SPPF may or may not have any on-site storage capacity.

- The SPPF may or may not have any on-site generation (either dependent generation and/or independent generation).

- The SPPF may or may not have any shiftable load capability.

Any SPPF configuration which provides for at least one degree of operational freedom may be considered. The only load configuration which is not of interest here is the case of a fixed load connected to the utility without any on-site generation nor any on-site storage.

CHAPTER 3

OPTIMIZATION POSSIBILITIES

3.1 GENERAL INPUT CONSIDERATIONS

Each optimization requires some general input data, which is common to every type of simulation request made by the user, as follows:

- The overall duration of the optimization procedure to be carried out. This data is given as the number of individual time intervals.

- The duration of each time interval to be used during the optimization procedure to be carried out. This duration is given in hours or in fraction of hours. It should be noted that it is assumed that all time intervals are of the same length over the entire time span covered by the optimization.

- All applicable efficiencies are given for the entire time span to be covered by the optmization procedure. It should be noted that this assumes that the said efficiencies are the same for all time intervals during the entire optimization time span. This assumption can easily be relieved from an algorithmic point of view; however, it is felt that the extra input required would unnecessarily burden the user and that the constant efficiency assumption is very often valid.

- The rates at which energy can be stored and retrieved into, respectively out of, the storage device are set for the entire time span covered by the optimization procedure. These rates are given in Wh/h, KWh/h, or MWh/h. Again, these rates are assumed to be constant for all time intervals over the entire optimization time span.

3.2 OPTIMUM SCHEDULE CONCEPT

In this Chapter reference will often be made to the optimum schedule. A word of clarification is appropriate at this early point. By optimum schedule one here intends the schedule which maximizes the revenue for the small power producing facility or which minimizes its energy costs, the two concepts being identical from a formulation point of view. The optimum schedule is determined taking the various input parameters into account as will be outlined in the subsequent paragraphs. It is important to remember that the schedules derived are optimum for the SPPF and not necessarily for the utility from a sheduling point of view.

3.3 OPTIMUM GENERATION SCHEDULE FOR FIXED LOADS

The simplest problem addressed by the proposed techniques is that of optimizing the generation schedule for a Small Power Producing Facility when the load schedule is totally set. In this case the user selects the following input parameters:

- The actual load demand during each time interval over the entire time span to be covered by the optimization. This data is given in Wh, KWh, or MWh for each time interval.

- The maximum local generation capability during each time interval over the entire time span covered by the optimization. This data is given in Wh, KWh, or MWh for each time interval.

- The energy prices for selling energy back to the utility during each time interval over the entire time span covered by the optimization. This data is given in $/Wh, $/KWh, or $/MWh for each time interval.

- The energy prices for purchasing energy from the utility during each time interval over the entire time span covered by the optimization. This data is given is $/Wh, $/KWh, or $/MWh for each time interval.

- The energy costs to generate energy locally, using the local generating facilities, for each time interval over the entire time span covered by the optimization. This data is given in $/Wh, $/KWh, or $/MWh for each time interval.

- The maximum capacity of the energy storage device. This data is given in Wh, KWh, or in MWh.

The resulting output provides the following information for each time interval:

- The actual energy produced locally for each time interval, in Wh, KWh, or MWh.

- The actual energy produced by the dependent generation facility for each time interval, in Wh, KWh, or MWh. These values are clearly zero if the facility does not provide for dependent generation.

- The actual energy usage for each time interval, in Wh, KWh, or MWh. These values simply repeat the input data for this particular situation since no shiftable loads are assumed. Should shiftable loads be provided for, then these energy usage levels would be outputs from the optimization procedure.

- The amount of energy sold back to the utility during each time interval, in Wh, KWh, or MWh.

- The amount of energy purchased from the utility for each time interval, in Wh, KWh, or MWh.

- Amount of energy stored during each time interval, in Wh, KWh, or MWh.

- The amount of energy lost in the small power producing facility during each time interval , in Wh, KWh, or MWh, and taking the various efficiencies into account.

- The amount of profit made by the small power producing facility during each time interval, in dollars.

- Finally, the program provides the total revenue for, or the total cost to, the Small Power Producing Facility over the entire time span covered by the optimization. This revenue, or cost, is the largest revenue, or the lowest cost, to the Small Power Producing Facility given the various energy rates, power producing costs, and related efficiencies. This revenue, or cost, is given in dollars.

3.4 OPTIMUM GENERATION SCHEDULE FOR SHIFTABLE LOADS

The next logical extension to the fixed load situation is the provision for shiftable loads. This model is provided to accomodate those loads where some scheduling flexibility does exist and should be taken advantage of in determining the optimum generation schedule. In this case the user selects the following parameters:

- The total energy demand, in Wh, KWh, or MWh, to be covered over the entire time span of the optimization period, as well as the minimum and maximum energy demand limits for any one time interval during the entire optimization time span. This model of the loads provides for a SPPF where the total energy needs are known and where the minimum and maximum power demand are also known and where some scheduling flexibility exists. This could well be the case for a large industrial plant where several work shifts are used but where the plant does not run at full capacity 24 hours a day and where it is also known that the plant cannot be practically shut down for only short periods of time.

- The remaining input data required is identical to that required for the fixed load case discussed in Paragraph 3.3., with the exeption that the actual load schedule is no longer given.

The resulting output provides for the identical information as for the fixed load case discussed in Paragraph 3.3.

3.5 OPTIMUM GENERATION SCHEDULE FOR SHIFTABLE LOADS AND DEPENDENT GENERATION

Once the shiftable load model is accomodated for, the next model extension to be incorporated is the consideration of the dependent generation situation. Dependent generation is considered separately from indendent generation for this model. Indeed, for the independent generation one assumes that the generation schedule can be set independently from the actual load level; however, for the dependent generation this is not true as the dependent generation output is directly tied to the output level. For the proposed model the dependent generation is such that it is equal to the actual load level multiplied by a proportionality factor. The dependent generation proportionality factor is assumed to be constant over the entire optimization period . However, this assumption can readily be relieved from an algorithmic point of view.

Dependent generation simulation is only of interest for shiftable loads. Indeed, for fixed loads, dependent generation can be considered as a fixed offset for all loads in view of the proportionality existing between the loads and the dependent generation output.

For the optimization situation with shiftable loads and dependent generation the user selects the following input parameters:

- The proportionality constant for the dependent generation output level as it relates to the load level.

- The remaining input parameters are identical to those for the shiftable loads discussed in Paragraph 3.4.

The resulting output provides the same type of information as for the shiftable loads discussed in Paragraph 3.4.

3.6 DETERMINATION OF THE OPTIMUM STORAGE CAPACITY

In the previous three optimization situations it was assumed that the available storage capacity was known and was provided as an input parameter. This assumption is generally valid for existing facilities. However, in several instances the potential user of a storage facility may want to determine what is the optimum amount of storage to be installed taking into account the selling and buying utility rates, as well as the other local facility design parameters. This is clearly a design type of issue and it could be argued that it should not be addressed in a scheduling optimization study. However, the project research has shown that this particular question, as well as other design parameter issues, can be rather elegantly addressed and answered using numerical techniques which are similar to those used for the scheduling optimization.

The storage capacity can be optimized for the three situations examined previously: fixed loads, shiftable loads, and shiftable loads with dependent generation. For each case the user selects the input parameters as explained in Paragraphs 3.3. through 3.5., depending on the type of load and dependent generation situation to be considered. In addition, the user must select:

- The capital cost of the storage device to be installed, in dollars per Wh, dollars per KWh, or in dollars per MWh.

The resulting output provides the same types of informations as outlined in Paragrphs 3.3. through 3.5., depending on the type of load and dependent generation situation to be considered. In addition, the following output results are provided:

- The optimum storage capacity to be installed given the input parameters used. This optimum storage capacity is clearly dependent on the cost per installed Wh of storage.

- The initial storage level to be used for an optimum schedule for the small power producing facility. This is an important change when compared to the previous situations where the initial storage level was assumed to be known in addition to the storage capacity. It is important to note that in all cases the initial and final storage level for the entire optimization period are assumed to be identical. Failure to incorporate this latter constraint could mean that the resulting optimum schedule would not be repeatable.

3.7 OPTIMUM PRICING STRATEGY

Once the optimum generation schedule has been obtained for a particular load schedule, remains the following question:

> "For this particular generation schedule as it is, is there a better set of energy prices, both selling and buying, which are more favorable to the utility while still preserving the existing schedule? If this is so, determine what the best set of prices is for the utility."

This question could be viewed as being contradictory to the previous goal of determining the best schedule for the Small Power Producing Facility. In reality it is not contradictory at all. Rather, one tries to find a set of energy prices for the exchanges between the SPPF and the utilty which are such that when the SPPF optimizes its schedule, based on these prices, as to maximize his profit, then the resulting schedule is the same as the previously determined schedule; however, the "revenue" created for the utility (which could be negative if the user makes a true profit) is also maximized.

This particular problem has been addressed and solved using an extension of the model previously outlined and using some key properties of the solution to any Linear Programming maximization problem.

For this particular type of optimization problem, the user selects the following input parameters:

- The actual load demand during each time interval over the entire time span to be covered by the optimization. In the case of shiftable loads, this data would be the result of an optimization carried out using the existing price structure as explained in Paragraph 3.4. This data is given in Wh, KWh, or MWh for each time interval.

- The remaining input data required is identical to that required for the fixed load case discussed in Paragraph 3.3.

The resulting output data is a set of utility selling and buying energy rates for each time interval over the entire optimization period. These new energy prices can be used again in a standard generation schedule optimization, the result of which will give an unchanged generation schedule but where the Small Power Producing Facility's revenue will be reduced compared to the situation using the non-optimized prices.

3.8 OPTIMUM PRICING CHANGE FOR A SCHEDULE CHANGE

Once the optimum pricing strategy problem is addressed and solved, a new question can be asked as follows:

> "Can one predetermine what set of prices will induce a specific user reponse to create a more favorable user response during an emergency, for example. If such a set of prices exist they should be optimized for the utility, as outlined in Paragraph 3.7., and should be such that when the Small Power Producing Facility goes through its generation schedule optimization procedure, then the result should be such that it satisfies the operational constraints imposed by the utility."

Again, this is somewhat of an extension to the optimum generation schedule problem, but it is certainly related. Indeed, when spot prices are used, it is only natural to assume that the utility may well want to have the possibilty to encourage some particular SPPF participation during the operational cycle. One such examples are the participation in the peak generation requirement; in this case the utility would set some upper limit to the energy purchase that it would like to see observed by the Small Power Producing Facility. Another example could well be the utilisation of excess available bulk generation from the utility; in this case the utility would set some lower limit to the energy purchase that it would like to see observed by the Small Power Producing Facility. In both of these cases the utility would like to determine the best set of prices to be communicated to the SPPF and that would induce the desired behavior in the said SPPF.

It is clear that the optimum pricing strategy and the optimum prices for a schedule change are optimization procedures to be used by the individual utility before releasing a new set of energy spot prices to the Small Power Producing Facilities.

The input parameters selected by the user are the same as for the optimum pricing strategy discussed in the previous Paragraph with the additional desired operating constraints specified by the user.

The output provided will be a new set of prices, both for selling and buying energy, which are such that when they are used by the Small Power Producing Facility in a generation schedule optimization they would result in a new schedule which would satisfy the utility imposed constraints.

CHAPTER 4
MATHEMATICAL DESCRIPTION

4.1. BACKGROUND

Introduction

To predict the behavior of different customers to price changes, a model is desired that could be employed for a variety of cases with minimum effort. For example, a customer may or may not have generation and/or storage facilities. In addition to being simple for implementation, the model should be capable of representing the basic operating decisions of the prospective customers, e.g., buying, selling, and storing of energy. Capeheart et. al. (8) in 1982 proposed a model for a small power production facility that is both adequately sophisticated and sufficiently flexible. The proposed basic model is a variant of the Capeheart's model in which several adjustments are made. First, shiftable-loads modeling capability is added to the model. Second, the model is extended to include cogeneration* modeling capability. Third, the model is upgraded to be useful for representing lossy storage devices. Forth, it is assumed that each unit of energy stored in a given interval, t, can be retrieved no sooner than the next interval, t+1. And finally, some efficiency factors are assigned to the tie lines to remove the anomaly of simultaneous buying and selling, when the buying and the selling prices are equal.

These adjustments make the model suitable for a larger class of customers than the original Capeheart model. Note that in the basic model, storing and retrieving of energy can be done in any order during an

* In chapter 4 one will refer to dependent generation as "cogeneration"

interval, i.e., the two operations are functionally independent. In the Capeheart model, on the other hand, it is assumed that the retrieving of energy from the storage must always occur after the storing of energy is completed in the same interval. Nevertheless, the model will manifest anomaly for the cases when the selling price by the utility is less than its buying price. Fortunately, such cases are rare and can be eliminated using the optimum pricing technique to be discussed later in detail.

In the following sections the basic model will be presented along with a discussion as to how it may be modified to be applied to other interesting problems such as optimum storage capacity, optimum schedules for shiftable loads, and optimum cogeneration scheduling.

Model Description

Basic operations of small power producing facilities can be represented by the model shown in Fig. 1. To match this model to a specific facility, some of the energy flow lines may have to be "disconnected". For example, if a given facility does not have any storage device, lines 1, 2, 6, 7, and 9 have to be disconnected. Since a variable, Y_{ik}, is assigned to each branch i for each interval k ($1 \leqslant k \leqslant N$), disconnecting a line is analogous to removing the corresponding variable from the formulation. Note that with this model it is possible to simulate time-dependent basic operations, e.g., predefined restricted usage or storage operation hours.

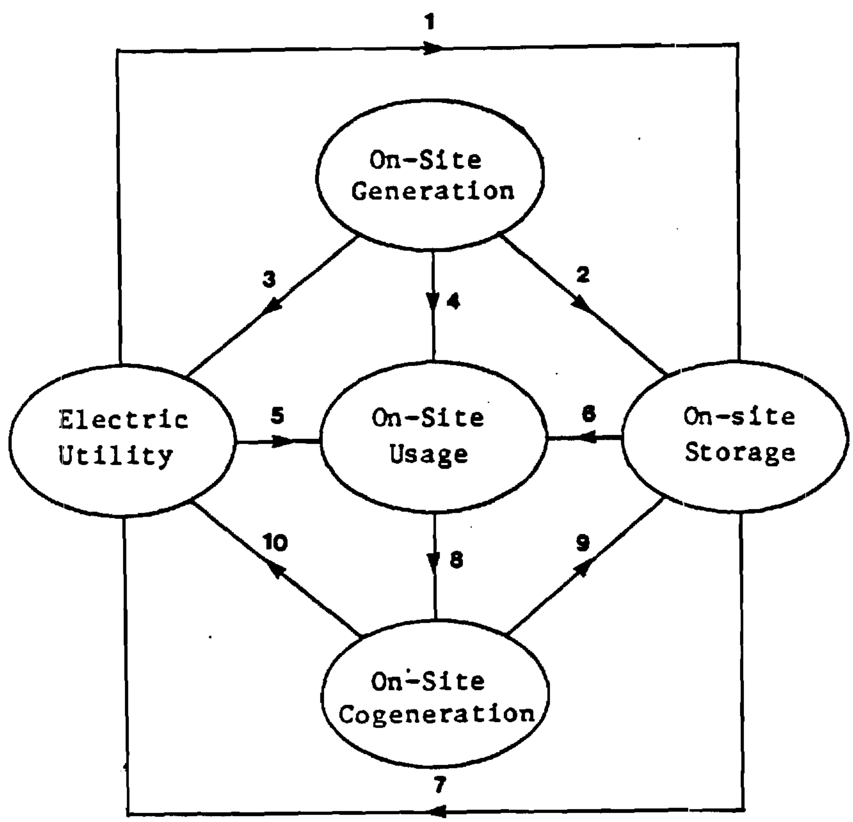


Fig. 1 - Feasible Energy Flows

Notations

Throughout this proposal the following notations will be used consistantly. The index k ($1 \leqslant k \leqslant N$) identifies the interval for which a variable is defined, and N is the total number of intervals in one optimization period.

G_k = On-site energy generation capacity (kwh),
U_k = On-site energy usage (kwh),
p_k = Buying price of energy for utility (\$/kwh),
q_k = Selling price of energy for utility (\$/kwh),
r_k = Energy generation cost for facility (\$/kwh),
Y_{ik} = Energy flow in the i-th branch.

Also,

R_1 = Maximum charging rate of the storage device (kw),
R_2 = Maximum discharging rate of the storage device (kw),
ε = Charging efficiency factor,
δ = Discharging efficiency factor,
X_o = Initial level of stored energy (kwh),
ΔT = Length of intervals (hours).

In addition,

α = Price of storage device (\$/kwh),
β = Cogeneration coefficient,
γ = Efficiency factor for the tie lines Y_{3k}, Y_{5k}, and Y_{10k},
μ = Storage loss factor,
ρ = Selling price for product of facility,
U_L = Minimum usage of energy (kwh),
U_H = Maximum usage of energy (kwh),
U_T = Total usage of energy (kwh),
P_L , P_U = Lower and upper limit for buying prices (\$/kwh),
q_L , q_U = Lower and upper limits of selling prices (\$/kwh).

Later on, it will be seen that some of the implicit restrictions imposed by the notations may be lifted without increasing the complexity of the formulations. For instance, the minimum and the maximum usages could be regarded as time-dependent limits with only minor changes in the formulations.

Formulation of Customer Response

The following formulation of the basic model is different from that of the Capeheart model in the additional features included in the basic model. Among these features are the capabilities for modeling shiftable loads, cogeneration, and lossy storage devices. Also, the operations of storing and discharging of energy are assumed to be independent, and the possibility of simultaneous buying and selling when selling and buying prices are equal is eliminated. The technique for the formulation of the basic model, however, is similar to that used by Capeheart.

Utilizing this modeling technique, the problem of optimum operation of a power producing facility with fixed loads can be formulated into a maximizing linear programming problem. The objective function is a linear function that represents the net revenue for the facility and the constraints are those imposed by the energy flow equations and inequalities. In the following discussions, the model of a facility with a fixed load schedule will be presented as the basic model. Cogeneration of the facility will be included after the modeling of shiftable loads is presented in a later section.

The <u>Objective Function</u> is given by:

$$\text{Maximize} \sum_{k=1}^{N} \left[p_k(Y_{3k}+Y_{7k})-q_k(Y_{1k}+Y_{5k})-r_k(Y_{2k}+(1/\gamma)Y_{3k}+Y_{4k})\right]$$

i.e.,

net revenue = total sale - total purchase - generation costs

The <u>Constraints</u> are:

$$k=1,2,\ldots,N$$

1) $\varepsilon\, Y_{1k} + \varepsilon\, Y_{2k} \leq R_1(\Delta T)$

i.e.,

the charging of the storage device should not exceed the limit set by the maximum charging rate. Note that R_1 may be time-dependent without increasing the complexity of the linear inequalities.

ii) $$Y_{2k} + (1/\gamma)\, Y_{3k} + Y_{4k} \leq G_k \qquad k=1,2,\ldots,N$$

i.e.,

the maximum generation should not exceed the maximum available generation during each interval.

In modeling the facilities without cogeneration, the lower limits of the generations will be zero and need not be included as separate constraints. When modeling cogeneration facilities with fixed loads, however, the amount of cogeneration during each interval may be added to both lower and upper limits of the generation, to transform the problem to that for a facility without cogeneration. In this case, time-varying lower limits for the generation should also be included to the set of the constraints.

iii) $$Y_{4k} + \gamma\, Y_{5k} + Y_{6k} = U_k \qquad k=1,2,\ldots,N$$

i.e.,

the usage is equal to the sum of the supplied energies.

iv) $$(1/\delta)Y_{6k} + (1/\delta)Y_{7k} \leq R_2(\Delta T) \qquad k=1,2,\ldots,N$$

i.e.,

the discharging of the storage device should not exceed the limit set by the maximum discharging rate. Note that R_2 may also be time-dependent without increasing the complexity of the constraints.

v) $$\mu^{j-1}X_o + \sum_{k=1}^{j} \mu^{j-k}\left[\varepsilon(Y_{1k}+Y_{2k}) - (1/\delta)(Y_{6k}+Y_{7k})\right] \leq S \qquad j=1,2,\ldots,(N-1)$$

i.e.,

the stored energy in each interval should not exceed the maximum storage capacity. Note that in this formulation the initial stored energy level, X_o, is a parameter, i.e., it will be optimized. However, if X_o is a known constant, the linear programming problem will have one less optimization variable.

vi) $$\mu^{j-1}X_o + \sum_{k=1}^{j-1} \mu^{j-k}[\varepsilon(Y_{1k}+Y_{2k})-(1/\delta)(Y_{6k}+Y_{7k})]-(1/\delta)(Y_{6j}+Y_{7j}) > 0$$

$$j=1,2,\ldots(N-1)$$

i.e.,

the retrieved energy at each interval should not exceed the available stored energy.

vii) $$\mu^{N-1}X_o + \sum_{k=1}^{N} \mu^{N-k}[\varepsilon(Y_{1k}+Y_{2k})-(1/\delta)(Y_{6k}+Y_{7k})] = X_o$$

i.e.,

the initial and the final level of stored energy should be the same. This assumption guarantees the repeatability of optimum operation schedules. When both the initial and the final stored energy levels are prespecified, this constraint becomes:

vii) $$\mu^{N-1}X_o + \sum_{k=1}^{N} \mu^{N-k}[\varepsilon(Y_{1k}+Y_{2k})-(1/\delta)(Y_{6k}+Y_{7k})] = X_o$$

where X and X are constant.

viii) $X_o < S$

i.e.,

the initial level of the stored energy should not exceed the maximum storage capacity. Note also that if X_o is a prespecified constant, the constraints (vii) and (viii) would be redundant.

This LP problem has a total of (7*N+1) variables and (6*N) constraints. The solution to this maximizing linear programming provides the schedule that maximizes the revenue of the small power producing facility subjected to the operational constraints. The rationale for each constraint has been purposely explained so that, later on, one will be ready to manipulate these constraints as well as the objective function for the formulation of other related problems.

4.2. OPTIMUM SCHEDULING

4.2.1. OPTIMUM SCHEDULE FOR SHIFTABLE LOADS

The problem of optimum scheduling of shiftable loads is important for both the design and the operation of small power producing facilities. It is concievable that, for a given distribution of prices, there exists an optimal load distribution that maximizes the net revenue for a customer. For facilities with shiftable loads, it is possible to schedule the loads in such a way as to acheive this optimal distribution. This schedule is a function of many parameters including storage parameters and the load constraints. The problem of optimum storage capacity will be handled separately in the next section, and the lower limit of the usage is set, when a facility is planned.

The upper limit of usage, on the other hand, depends on the maximum power consumption of the loads, e.g. electric melting ovens, and can be optimized for a set of predicted spot prices. The total energy consumption, U_T, during any period of optimization is a scheduling decision. Both the maximum power, U_H, and total energy consumption, U_T, of the loads in an optimization period may be optimized using a formulation similar to the one for the optimum storage capacity. If the facility already exists, the maximum power consumption of the load is fixed, and only the total energy consumption of the load may be subjected to the optimization process.

In the following discussion, it is shown that the formulation for the basic model may be enhanced to be used for more complex scheduling problems.

Formulation

The Objective function is given by:

$$\text{Maximize} \sum_{k=1}^{N} \left[p_k(Y_{3k}+Y_{7k})-q_k(Y_{1k}+Y_{5k})-r_k(Y_{2k}+(1/\gamma)Y_{3k}+Y_{4k}) \right]+\rho U_T$$

where the last term is the revenue from the sales of the products of the facility. This term is a constant if the total energy consumption in the optimization period is prespecified. When designing the facility or optimizing the total energy consumption of the loads, U_T will be an optimization parameter and not a constant.

The constraints are the same as for the base model except for the following changes. Replace (iii) by

iii)-a $\quad Y_{4k} + \gamma Y_{5k} + Y_{6k} - U_k = 0 \qquad K=1,2,\ldots,N$

iii)-b $\quad -U_k \leq -U_L \qquad K=1,2,\ldots,N$

iii)-c $\quad U_k \leq U_H \qquad K=1,2,\ldots,N$

Also add

viii)-a $\quad \sum_{k=1}^{N} U_k = U_T$

If U_T is prespecified, there will be (8*N+1) variables and (8*N+1) constraints. Similarly, if U_T is a parameter to be optimized, the formulation will have one more variable but the same number of constraints as above.

4.2.2. OPTIMUM SCHEDULE WITH COGENERATION

In specifically designed facilities, it is possible to utilize the by-product energies, such as the generated heat, to generate electrical power. This form of generation that essentially is a function of the loads is called cogeneration. Altough cogeneration capability increases the output of a facility, the added investments and operating costs are major factors in the economical feasibility of such added capability to a facility. Only the operational aspect of this type of economical feasibility questions can be answered by the proposed formulation. Also, the cogeneration of the facility will be assumed to be a linear function of the load.

Similar to the scheduling of shiftable loads, the problem of the optimum scheduling of cogeneration facilities is important for both planning and operation of the facilities. Modeling of cogeneration for fixed loads can be transformed into the modeling of facilities without cogeneration capability, using a time-varying lower bound on the generation. Also, following the same arguments as for the shiftable loads, the maximum power and the total energy consumption of the load can be optimized for a known distribution of spot prices. Also, if the facility already exists, only the total energy consumption of the load may be optimized.

Formulation

The Objective function is given by:

$$\text{Maximize} \sum_{k=1}^{N} \left[p_k(Y_{3K}+Y_{7k}+Y_{10k})-q_k(Y_{1k}+Y_{5k})-r_k(Y_{2k}+(1/\gamma)Y_{3k}+Y_{4k})\right]+\rho u_T$$

The Constraints are the same as for shiftable loads except for the following changes. Replace (i) by,

i) $$\varepsilon\, Y_{1k} + \varepsilon\, Y_{2k} + \varepsilon\, Y_{9k} \leq R_1(\Delta T) \qquad K=1,2,\ldots,N$$

Replace (v) by,

v)-a $$\mu^{j-1}x_o + \sum_{k=1}^{j} \mu^{j-k}\left[\varepsilon(Y_{1k}+Y_{2k}+Y_{9k})-(1/\delta)(Y_{6k}+Y_{7k})\right] \leq S \qquad j=1,2,\ldots,(N-1)$$

Replace (vi) by,

vi)-a $$\mu^{j-1}x_o + \sum_{k=1}^{j-1} \mu^{j-k-1}\left[\varepsilon(Y_{1k}+Y_{2k}+Y_{9k})-(1/\delta)(Y_{6k}+Y_{7k})\right]-(1/\delta)(Y_{6j}+Y_{7j}) \geq 0 \qquad j=1,2,\ldots,(N-1)$$

Replace (vii) by,

vii)-a $$(\mu^{N-1}-1)x_o + \sum_{k=1}^{N-1} \mu^{N-k-1}\left[\varepsilon(Y_{1k}+Y_{2k}+Y_{9k})-(1/\delta)(Y_{6k}+Y_{7k})\right]-(1/\delta)(Y_{6N}+Y_{7N})=0$$

Also, add the following constraints:

iii)-d $$-\beta U_k+Y_{9k}+(1/\gamma)Y_{10k} \leq 0 \qquad k=1,2,\ldots,N$$

That is, the cogenerated energy must either be stored or sold and cannot be used at the same interval. This assumption prevents the perpetuity problem that, otherwise, exists. If U_T is prespecified, there will be (10*N+1) variables and (8*N+1) constraints in the formulation. Again, if U_T is a parameter to be optimized, the formulation will have one more variable but the same number of constraints as above. See Appendix-2 for a summary of the formulation for optimum scheduling. Note that the storage capacity, S, is a prespecified constant in the formulation of Appendix-2 for optimum scheduling problem.

4.3. OPTIMUM FACILITY DESIGN

4.3.1. OPTIMUM STORAGE FACILITY

When the distribution of spot prices is known, it is possible to include the design parameters of a facility, such as storage capacity, into the formulation for the optimum scheduling and simultaneously compute the optimum operating schedule and the optimum values for the design parameters. Specifically, when the total energy consumption is prespecified, two design parameters are subject to be optimized: the optimum storage capacity and the maximum power consumption of the load.

One can show that is feasible to formulate the joint optimization of these two design parameters as one maximizing linear programming problem similar to those for optimum scheduling. In practice, however, one of the parameters may be prespecified, so the number of the variables of the problem may be reduced. Having gone through the rationales for the constraints in the previous sections, one is able to demonstrate a summary of the formulation for the joint optimization of the two parameters and, extract from it, the formulation for the separate optimization of each parameter.

<u>Formulation</u>

The <u>Objective</u> function is given by

$$\text{Maximize} \sum_{k=1}^{N} \left[p_k(Y_{3K}+Y_{7k}+Y_{10k})-q_k(Y_{1k}+Y_{5k})-r_k(Y_{2k}+(1/\gamma)Y_{3k}+Y_{4k})\right]+\rho u_T-N(\Delta T)\alpha S$$

The Constraints are the same as for scheduling of the facilities with cogeneration capability included, except that S, U_T, and U_H are considered as variables and not constants. There will be (10*N+3) variables and (9*N+1) constraints. A summary of the formulation is given in Appendix-2. If U_T and U_H are both prespecified, the formulation will have two less variables but the same number of constraints as above.

4.4. OPTIMUM PRICING

Introduction

In the previous sections it has been shown, in details, how to model the behavior of profit-maximizing small power producing facilities as maximizing Linear Progrmming (LP) problems. These LP problems may be solved by any standard computer routines for solving LP problems, and the solutions will be the optimum schedules for the facilities.

One important question is whether there are other sets of spot prices that yield the same optimum schedule, i.e., the optimum schedule for the old set of prices will also be the optimum schedule for the new set of prices. If such sets of prices exist, it is desirable to find the set of prices that is optimum for the utility, i.e., minimizes the net revenue of the facilities. These prices will be called "the optimum prices for an optimum schedule", and the technique will be called "the optimum pricing technique".

Another important question is whether it is possible to modify the set of prices, in such a way, that the optimum schedule for the new set of prices be more favorable to the utility. For instance, during emergencies, the utility seeks full cooperation of the small power producing facilities, and this can be achieved by appropriate selection of the spot prices. This application of spot pricing is perhaps the main force behind the whole idea of spot pricing. Hence, it is desirable to identify a technique for computing the set of spot prices that induces a particular behavior to those customers that react optimally, i.e., those who maximize their short-term profits. The optimal prices that induce a desirable change in the optimum schedule will be called "the optimum prices for a schedule change".

Background

The starting point for computing the optimum prices for both the optimum schedule and a schedule change is the LP formulation for the behavior of small power producing facilities. Specifically, the formulations of appendices 1 and 2 will be transformed into new optimization problems for the spot prices. Before the details of the techniques are presented, it is necessary that the logic for the correctness of the techniques be explained.

The LP problems of appendices 1 and 2 are of the form:

$$\text{Maximize } Z = C^t X$$

$$\text{Subject to } A\, X \leqslant b$$

$$X \geqslant 0.$$

Where,

$$C = \begin{bmatrix} c_1 \\ c_2 \\ \cdot \\ \cdot \\ \cdot \\ c_n \end{bmatrix} \qquad X = \begin{bmatrix} x_1 \\ x_2 \\ \cdot \\ \cdot \\ \cdot \\ x_n \end{bmatrix} \qquad A = \begin{bmatrix} a_{11} & a_1 & \cdot & \cdot & \cdot & a_{1n} \\ a_{21} & a_{22} & \cdot & \cdot & \cdot & a_{2n} \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ a_{m1} & a_{m2} & \cdot & \cdot & \cdot & a_{mn} \end{bmatrix}$$

The two well-known techniques of Simplex and Dual-Simplex methods are usually employed for solving such LP probelms. These Simplex techniques are well established, and the details of the techniques may be found in many related text books (33). However, there are, specifically, three properties of the Simplex tableaux that are most important for the optimum pricing technique. These properties are explained in the subsequent sections.

4.4.1. OPTIMUM PRICES FOR AN OPTIMUM SCHEDULE

Given a maximization Simplex tableau, a well-known property of an optimal solution is the following:

<u>Property 1</u>

A solution of a maximizing LP is optimal if all entries of the C row are non-positive, i.e.,

$$C^t - C_B^t B^{-1} A \leq 0 \tag{1}$$

where C, C_B, B^{-1}, and A are the vector cost, the vector cost of the basic variables, the inverse matrix of the basis, and the constraints matrix, respectively [see Phillips et. al. (33)].

The optimum solution for the basis B, on the other hand, is given by

$$X^0 = \left(\frac{X_B}{X_N}\right) = \left(\frac{B^{-1}b}{0}\right) \tag{2}$$

where X_B, X_N, and b are the basic variables, the non-basic variables, and the constants of the constraints, respectively. It is interesting to note that the optimal solution (2) remains optimum for any other cost vector that satisfies (1). Since for a given optimum solution $B^{-1}A$ is known, the set of inequalities (1) may be interpreted as linear constraints, and the cost vector as variables. So a new LP problem could be formed that would yield the optimum costs for a prespecified objective function. The details of this procedure are as follows: Expand (1) as

$$[\bar{C}_B^t \mid \bar{C}_N^t] = [C_B^t \mid C_N^t] - C_B^t B^{-1} [A_B \mid A_N] < 0 \qquad (1)^*$$

where C_B and C_N are the costs of basic and non-basic variables, respectively. A_B and A_N are submatrices of A corresponding to basic and non-basic variables. Since $\bar{C}$ is equal to 0, (1) yields

$$\bar{C}_N^t = C_N^t - C_B^t B^{-1} A_N < 0 \qquad (3)$$

Let

$$C_N^t = [C_{0N}^t \mid 0^t]$$

where C_{0N} is the vector cost of the actual, i.e., non-slack, non-basic variables. Note that the costs for slack variables are zero. Now (3) may be rewritten as

$$[\bar{C}_{0N}^t \mid \bar{C}_{1N}^t] = [C_{0N}^t \mid 0^t] - [C_{0B}^t \mid 0^t] \left[\begin{array}{c|c} A_{0N} & A_{1N} \\ \hline - & - \end{array}\right] < 0 \qquad (4)$$

where,

$$B^{-1} A = \left[\begin{array}{c|c} A_{0N} & A_{1N} \\ \hline - & - \end{array}\right]$$

and

$$\overline{C}_N^t = [\overline{C}_{0N}^t \mid \overline{C}_{1N}^t]$$

(4) yields,

$$A_{0N}^t C_{0B} - C_{0N} > 0 \tag{5}$$

$$A_{1N}^t C_{0B} > 0 \tag{6}$$

(5) and (6) may be rewritten as

$$\left[\begin{array}{c|c} A^t_{0N} & -I \\ \hline A^t_{1N} & 0 \end{array}\right] \begin{bmatrix} C_{0B} \\ C_{0N} \end{bmatrix} > 0 \tag{7}$$

These are the linear inequalities to be used in the optimization problems for the prices. Of course, other constraints such as lower and upper bounds of the costs must also be added to the constraints. These additional constraints will be discussed later.

Objective function

The new objective function for this optimization of the costs is simply given by

$$\text{Minimize} \quad W = X^{0t}\, C = \left[X^{0t}_{0B} \mid 0^{t}\right] \begin{bmatrix} C_{0B} \\ \hline C_{0N} \end{bmatrix}$$

where X^{ot} is the optimum operating schedule for which the optimum prices will be determined. The rationale for this objective function is that the utility will try to set the spot prices such that it has to obtain the greatest profit from the customer or pay the least to the customer.

Other constraints

First, the costs are subjected to lower and upper limits. Second, there are restrictions on the costs and on the relationships among the costs. These restrictions are:

- some costs are always positive,
- some costs are always negative,
- some costs are always constant,
- some costs are equal to some others,
- some costs cannot be larger than some others.

If the rows corresponding to the negative costs in (7) are multiplied by -1, all prices will become positive, as desired in a standard LP formulation. Also, if the columns corresponding to equal costs are added up together to form a single column for all equal prices, the multiplicity of the prices will be eliminated. This technique for handling equal prices, actually, reduces the size of the constraints matrix. For each price which is less than another price one constraint will be added to the set of the constraints. Hence, only constant costs remain to be manipulated.

After removal of negativeness and multiplicity of the prices and addition of the inequality constraints of above, (7) may be rewritten as

$$\begin{bmatrix} A_{11} & A_{12} & A_{13} \\ A_{21} & A_{22} & A_{23} \\ A_{31} & A_{32} & A_{33} \end{bmatrix} \begin{bmatrix} p \\ q \\ c \end{bmatrix} > 0 \tag{8}$$

where p , q , and c are buying prices, selling prices, and constant prices, respectively. (8) yields

$$\begin{bmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \\ A_{31} & A_{32} \end{bmatrix} \begin{bmatrix} p \\ q \end{bmatrix} > - \begin{bmatrix} A_{31} \\ A_{32} \\ A_{33} \end{bmatrix} \begin{bmatrix} c \end{bmatrix} \tag{9}$$

Note that the right hand side of (9) is a constant vector. These constraints are also in the standard LP form. So the complete formulation for the optimum pricing technique is given in Appendix-3.

In Appendix-3, X^{*t} is the optimum schedule that is changed to account for negativeness, multiplicity, and constantness of the costs. (iv) is included to inforce the relationship between buying and selling prices.

Modified Prices

According to the LP theory, the prices computed from eq. (1) will yield infinite number of optimum schedules for the facility. This is undesirable because the predicted schedule by the utility may be different from that computed by the utility, even though both schedules will have the same profit for the facility. Hence, it is interesting to know if one can deviate from the optimum prices by a small amount, while at the same time preventing the multiplicity of the optimum schedules. To compute the prices that guarantee a unique optimum schedule, (1) has to change to

$$\bar{C}_N^t = C_N^t - C_B^t B^{-1} A_N \leq -\varepsilon_1$$

where ε_1 is a strictly positive vector. The derivations of the prices for this case will be similar to those from (1) through (8).

4.4.2. OPTIMUM PRICES FOR A SCHEDULE CHANGE

There are two methods for inducing a change in the optimum schedule. First, the set of prices may be guessed and optimized by the optimum pricing technique of the previous section. Second, new constraints may be added to the LP problem that describes the desired behavior of small power producing facilities. These constraints will be called "the system constraints" and have to be relieved to yield an acceptable schedule for the original formulation of the problem without the system constraints. The optimum pricing technique of the previous section will, then, be utilized to compute the optimum prices for this modified schedule.

An explicit application of the first method will be disscussed later under the name of "the optimum peak-load pricing". The details of the second method are as follow.

The following two properties are well-known properties of Simplex tableaux.

Property 2

If s_i is a non-basic variable of the final Simplex tableau, then the i-th constraint will be an equality relation, i.e., to relax the i-th constraint, one must force s_i to become a basic variable.

Property 3

If the inequality constraints corresponding to the inequality relationships in the final Simplex tableau are removed from the original LP constraints, this later LP problem will have the same optimum solution as the original LP problem, though it has fewer number of constraints.

Utilizing these two properties, an algorithm for computing the optimum prices for a favorable change in the operating schedule of small power producing facilities will be as follows:

i) Formulate the behavior of the customers as in appendices 1 and 2.

ii) Add a new set of constraints that induces the desirable change.

iii) Apply Simplex technique to find the optimum solution of the modified problem.

iv) By repeated application of property 2, relieve all the system constraints. The new schedule, of course, may not be optimal.

v) Use optimum pricing to compute the optimum prices for this schedule. If the optimum prices exist, the schedule will become optimal for this set of prices. Property 3 guarantees that for this set of prices above schedule will be the schedule for the LP without the system constraints.

CHAPTER 5

PROGRAM DESCRIPTIONS

5.1 INTRODUCTION

During this project, four major computer programs where designed, implemented, debugged, and fully tested. These four programs are:

- PROGRAM TSCH1

- PROGRAM TSTG1

- PROGRAM TPRX1

- PROGRAM TSCH

The purpose of this Chapter is to provide a brief description of all four programs. A separate User's Guide is available to assist in the creation of the required input files and to provide detailed information as to their various output capabilities.

The programs are written in standard Fortran code, are implemented on the CDC CYBER computer system available at the Georgia Institute of Technology. Few outside library programs or routines are used; they primarily relate to a classical Linear Programming optimization procedure and to the graphical output procedure required to provide for the plotting of the various load curves, as described in Chapter 7, on a CALCOMP plotter. Further details regarding these library programs are provide in the User's Guide.

5.2 PROGRAM TSCH1

This program, Tva SCHedule 1, is used to determine the optimum schedule for any single SPPF. The major features of this program are:

- It can handle a SPPF having a fixed load schedule or having shiftable loads.
- It can handle any combination of independent generation and/or of dependent generation.
- It can handle any level of energy storage capacity, including none at all. However, the energy storage capacity is an input parameter for Program TSCH1.

The inputs and outputs for Program TSCH1 are as described in Chapter 3.

Program TSCH1 is designed to specifically solve any scheduling problem for a particular SPPF.

5.3 PROGRAM TSTG1

This program, Tva SToraGe 1, is used to determine the optimum storage capacity for any single SPPF once the related energy selling and buying rates are set, once the local generation costs are set, and once the related capital costs are set. The major features of this program are:

- It can handle a SPPF having a fixed load schedule or having shiftable loads.
- It can handle any combination of independent generation and/or of dependent generation.
- In this case the energy storage capacity is an output of the program along with the resulting optimum schedule obtained for that particular energy storage capacity.

The inputs and outputs for Program TSTG1 are as described in Chapter 3.

Program TSTG1 is used to solve the design problem related to the on-site energy storage capacity level.

5.4 PROGRAM TPRX1

This program ,Tva PRice 1, is used to carry out the optimum pricing related optimizations. It must be noted here that this program only handles the case of fixed load schedules, which are provided as input, since the purpose is duplicate a particular schedule or to modify a particular schedule by manipulating the energy selling and buying prices.

This program can handle two sets of problems:

- Determine the optimum prices, from the utility's point of view, to maintain a given schedule for the SPPF. This problem may not be of apparent interest to the TVA situation. However, such a determination could be highly useful when considering a particular SPPF rate structure in conjunction with the overall rate design for the entire utility, including all non-SPPF loads, given the fact that TVA must maintain a revenue neutral overall rate design philosophy.

- Determination of the optimum price structure to "induce" a particular behavior into a particular SPPF. This is of immediate interest to any utility when it tries to seek a particular pattern of collaboration from its various SPPF's.

The inputs and outputs for the program are as described in Chapter 3.

Program TPRX1 is primarily to be used by the rate design department of any utility and for emergency relief situations where particular SPPF behaviors are sought.

5.5 PROGRAM TSCH

This program, Tva SCHedule, handles the overall SPPF scheduling problem for all SPPF's connected to a particular utility. This program incorporates the influence of all SPPF's into a system load curve taking the non-SPPF system load into account. Several so-called "quality factors" are also computed.

The capabilities of this program will be further discussed in Chapter 7. At this point it is sufficient to say that Program TSCH can repeat the procedures used by Program TSCH1 for any number of SPPF's and then integrate the results on a system wide basis.

CHAPTER 6

NUMERICAL RESULTS, ILLUSTRATION CASES

6.1 PRELIMINARY REMARKS

In this Chapter a set results are presented for one particular Small Power Producing Facility and for two different generation configurations for that same SPPF. A series of optimization problems are presented using this data for illustration purposes. These results were obtained using the TSCH1, TSTG1, and TPRX1 programs. Chapter 7 presents a set of data for the entire TVA system as modeled for 1990 and using the TSCH program.

6.2 NOTATIONS

The following notations are used throughout the numerical results presented in this Chapter:

IOPT : Options available: 1) Fixed loads

3) Shiftable loads

5) With dependent generation

DT : Time interval (hours)

N : Number of intervals in the optimization period

R1 : Maximum storage charging rate (KW)

R2 : Maximum storage discharging rate (KW)

S : Maximum storage capacity (KWh)

ALFA : Price of installed storage capacity ($/KWh)

BETA : Coefficient of proportionality for dependent generation

DEL : Discharging efficiency

EPS : Charging efficiency

K : Index for the time intervals

P(K) : Selling price of energy by SPPF ($/KWh)

Q(K) : Buying price of energy for SPPF ($/KWh)

R(K) : Cost of local energy production ($/KWh)

G(K) : Maximum local energy production limit (KWh)

U(K) : Actual local energy usage (KWh)

UT : Total energy consumption, over the entire optimization period, for shiftable loads

UL : Lower limit of energy consumption during any time interval, for shiftable loads

UH : Upper limit of energy consumption during any time interval, for shiftable loads.

6.3 ACTUAL NUMERICAL EXAMPLES

A series of numerical examples are presented in this section. Although both the input parameters and output results are selfexplanatory, a few comments are useful.

In all cases the optimization period is 24 hours long and is divided into eight equal periods of 3 hours each.

In all cases the maximum charging and discharging rates are set to be 100 KW. The associated charging and discharging efficiencies are set to 80%.

Two sets of results are presented for the same small power producer. In in the first case, the maximum local generation during any single time interval is limited to 125 KWh. In the second case, the maximum local generation during any single time interval is limited to 900 KWh. All other data is identical for the two cases presented.

6.3.1 Fixed load scheduling

The related output results are given in Example 1(A) and Example 5(A) for each of the two generation situations.

The cost to the SPPF is 191.47 for the lower generation capacity. The cost to the SPPF is 76.80 for the higher generation capacity.

6.3.2 Shiftable load scheduling

The related output results are given in Example 1(B) and Example 5(B) for each of the two generation situations.

The cost to the SPPF is 184.97 for the lower generation capacity. The cost to the SPPF is 73.58 for the higher generation capacity.

6.3.3 Shiftable load with dependent generation scheduling

The related output results are given in Example 1(C) and Example 5(C) for each of the two generation situations.

The cost to the SPPF is 43.46 for the lower generation capacity. The revenue for the SPPF is 69.14 for the higher generation capacity.

6.3.4 Optimum storage determination for fixed loads

The related output results are given in Example 2(A) and Example 5(D) for each of the two generation situations. It is important to note that for these two examples the assumed cost of installed storage capacity is zero. When carrying out the determination of the optimum storage capacity, the program also determines which is the best initial storage level to be used. This is in contrast to the regular scheduling process where the initial storage level is given as an input parameter by the user. It is still true in this case that the initial and final storage levels are the same to ensure the repeatability of the optimum schedule determined.

The optimum storage capacity is 900 for the lower generation capacity. The optimum storage capacity is 604.95 for the higher generation capacity.

The cost to the SPPF is 181.82 for the lower generation capacity. The cost to the SPPF is 71.30 for the higher generation capacity.

The initial storage level is 0.00 for the lower generation capacity. The initial storage level is 0.00 for the higher generation capacity.

One further result is presented , in Example 2(A1), for the lower generation capacity case but where the storage capacity is set at 1200, i.e. above the optimum storage capacity of 900 previously determined. As is to be expected, the cost to the SPPF remains unchanged at 181.82 which indicates that, indeed, the 300 extra storage capacity does not contribute to the optimum schedule for the SPPF as for as the optimum cost is concerned.

Two further sets of results are presented for the higher generation capacity case but where the cost of installed storage capacity is no longer assumed to be zero. These two output results are given in Example 5(G) and Example 5(H). As is to be expected, the optimum storage capacity decreases as the cost of installed storage capacity increases. Also, the cost to the SPPF increases as the cost of installed storage capacity increases.

6.3.5 Optimum storage determination for shiftable loads

The related output results are given in Example 2(B) and Example 5(E) for each of the two generation situations.

The optimum storage capacity is 900.00 for the lower generation capacity. The optimum storage capacity is 725.00 for the higher generation capacity.

The cost to the SPPF is 175.31 for the lower generation capacity. The cost to the SPPF is 67.57 for the higher generation capacity.

The initial storage level is 0.00 for the lower generation capacity. The initial storage level is 0.00 for the higher generation capacity.

6.3.6 Optimum storage capacity determination for shiftable loads and dependent generation

The related output results are given in Example 2(C) and Example 5(F) for each of the two generation situations.

The optimum storage capacity is 1200 for the lower generation capacity. The optimum storage capacity is 900 for the higher generation capacity.

The cost to the SPPF is 30.14 for the lower generation capacity. The revenue for the SPPF is 77.42 for the higher generation capacity.

The initial storage level is 300.00 for the lower generation capacity. The initial storage level is 0 for the higher generation capacity.

6.3.7 Optimum pricing determination

The optimum pricing determination results are given in Example 3(A) and Example 5(H) for each of the two generation situations. The schedules which are to be reproduced here, with a better revenue for the utility, are the fixed load schedules with optimum storage capacity installed. These results were presented in Paragraph 5.2.4.

The so-called Optimum Prices are such that they may not yield the exact same schedule as that for the original case. To overcome this difficulty, the epsilon perturbation is used to arrive at a unique schedule which is exactly identical to that of the original schedule. The resulting, so-called, Modified Optimum Prices are the prices to be retained to induce the exact same original schedule for the SPPF while "maximizing" the revenue for the utility.

Two further sets of results are presented in Example 3(B) and Example 5(I) for each of the two generation situations. These results are obtained using the Optimum Prices. They demonstrate the potential difficulty of having multiple schedules yielding identical revenue results. The resulting schedules, while yielding the best possible utility revenues, are not identical to the input schedules. These two examples are added here for illustration purposes only.

The two resulting schedules, using the Modified Optimum Prices, are presented in Example 3(C) and Example 5(J) for each of the two generation situations. By comparison, one can see that the two resulting schedules are identical to the schedules obtained in Example 2(A), respectively Example 5(D). The only differences are in the energy rates, both selling and buying, which result in different costs (higher costs or lower revenues) for the SPPF.

6.3.8 Optimum pricing strategy for schedule change

The related output results are given in Example 4(A) and Example 5(K) for each of the two generation situations. The output results are two sets of energy prices (selling and buying) for each time interval for the entire optimization period.

The adequacy of these two price structures are verified using the results presented in Example 4(B) and Example 5(L) for each of the two generation situations. As can be seen by inspection, the added operational constraints are satisfied using the new set of selling and buying prices. As it is to be expected, the total cost, or revenue, values are affected as well when compared to the original situation.

For the lower generation capacity one has started from the fixed load and optimum storage situation, presented in Example 2(A), and where the additional operational constraint is set on the maximum purchase level during any time interval. This type of constraint corresponds to a peak level limitation.

For the higher generation capacity one has started from the fixed load and optimum storage situation, presented in Example 5(D), and where the additional operational constraints are set on the maximum purchase level during any time interval and on the minimum sale during a particular time interval. This type of constraint is again of the peak level limitation type but where one also tries to induce user net generation during a specific time interval.

TABLE 1.

EXAMPLE 1(A) - OPTIMUM SCHEDLING: FIXED LOADS

IOPT= 1 DT= 3.00 N= 8
R1= 100.00 R2= 100.00 S= 0.00 EPS= .800 DEL= .800

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	.0138	.0168	.0100	125.00	975.96
2	.0139	.0170	.0100	125.00	970.56
3	.0157	.0191	.0100	125.00	949.68
4	.0240	.0294	.0100	125.00	915.84
5	.0402	.0492	.0100	125.00	921.24
6	.0347	.0424	.0100	125.00	889.56
7	.0257	.0314	.0100	125.00	903.96
8	.0187	.0228	.0100	125.00	904.68

XO= 0.00 REVENUE= -191.47 ERROR= 0

PERIOD \ K	1	2	3	4	5	6	7
1	0.00	0.00	0.00	125.00	850.96	0.00	0.00
2	0.00	0.00	0.00	125.00	845.56	0.00	0.00
3	0.00	0.00	0.00	125.00	824.68	0.00	0.00
4	0.00	0.00	0.00	125.00	790.84	0.00	0.00
5	0.00	0.00	0.00	125.00	796.24	0.00	0.00
6	0.00	0.00	0.00	125.00	764.56	0.00	0.00
7	0.00	0.00	0.00	125.00	778.96	0.00	0.00
8	0.00	0.00	0.00	125.00	779.68	0.00	0.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= 0.00

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LOSS	PROFIT
1	125.00	0.00	975.96	0.00	850.96	0.00	0.00	-15.57
2	125.00	0.00	970.56	0.00	845.56	0.00	0.00	-15.60
3	125.00	0.00	949.68	0.00	824.68	0.00	0.00	-17.03
4	125.00	0.00	915.84	0.00	790.84	0.00	0.00	-24.48
5	125.00	0.00	921.24	0.00	796.24	0.00	0.00	-40.40
6	125.00	0.00	889.56	0.00	764.56	0.00	0.00	-33.69
7	125.00	0.00	903.96	0.00	778.96	0.00	0.00	-25.67
8	125.00	0.00	904.68	0.00	779.68	0.00	0.00	-19.03

NET COST FOR SPPF = 191.47

TABLE 2.

EXAMPLE 5(A) - OPTIMUM SCHEDULING: FIXED LOADS

IOPT= 1 DT= 3.00 N= 8
R1= 100.00 R2= 100.00 S= 0.00 EPS= .800 DEL= .800

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	.0138	.0168	.0100	900.00	975.96
2	.0139	.0170	.0100	900.00	970.56
3	.0157	.0191	.0100	900.00	949.68
4	.0240	.0294	.0100	900.00	915.84
5	.0402	.0492	.0100	900.00	921.24
6	.0347	.0424	.0100	900.00	889.56
7	.0257	.0314	.0100	900.00	903.96
8	.0187	.0228	.0100	900.00	904.68

XO= 0.00 REVENUE= -76.80 ERROR= 0

PERIOD \ K	1	2	3	4	5	6	7
1	0.00	0.00	0.00	900.00	75.96	0.00	0.00
2	0.00	0.00	0.00	900.00	70.56	0.00	0.00
3	0.00	0.00	0.00	900.00	49.68	0.00	0.00
4	0.00	0.00	0.00	900.00	15.84	0.00	0.00
5	0.00	0.00	0.00	900.00	21.24	0.00	0.00
6	0.00	0.00	10.44	889.56	0.00	0.00	0.00
7	0.00	0.00	0.00	900.00	3.96	0.00	0.00
8	0.00	0.00	0.00	900.00	4.68	0.00	0.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= 0.00

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LOSS	PROFIT
1	900.00	0.00	975.96	0.00	75.96	0.00	0.00	-10.28
2	900.00	0.00	970.56	0.00	70.56	0.00	0.00	-10.20
3	900.00	0.00	949.68	0.00	49.68	0.00	0.00	-9.95
4	900.00	0.00	915.84	0.00	15.84	0.00	0.00	-9.47
5	900.00	0.00	921.24	0.00	21.24	0.00	0.00	-10.04
6	900.00	0.00	889.56	10.44	0.00	0.00	0.00	-8.64
7	900.00	0.00	903.96	0.00	3.96	0.00	0.00	-9.12
8	900.00	0.00	904.68	0.00	4.68	0.00	0.00	-9.11

NET COST FOR SPPF = 76.80

TABLE 3.

EXAMPLE 1(B) - OPTIMUM SCHEDULING: SHIFTABLE LOADS

IOPT= 3 DT= 3.00 N= 8
R1= 100.00 R2= 100.00 S= 0.00 EPS= .800 DEL= .800
UT= 7500.00 UL= 400.00 UH= 1000.00

K	P(K)	Q(K)	R(K)	G(K)
1	.0138	.0168	.0100	125.00
2	.0139	.0170	.0100	125.00
3	.0157	.0191	.0100	125.00
4	.0240	.0294	.0100	125.00
5	.0402	.0492	.0100	125.00
6	.0347	.0424	.0100	125.00
7	.0257	.0314	.0100	125.00
8	.0187	.0228	.0100	125.00

XO= 0.00 REVENUE= -184.97 ERROR= 0

K PERIOD	1	2	3	4	5	6	7	8
1	0.00	0.00	0.00	125.00	875.00	0.00	0.00	1000.00
2	0.00	0.00	0.00	125.00	875.00	0.00	0.00	1000.00
3	0.00	0.00	0.00	125.00	875.00	0.00	0.00	1000.00
4	0.00	0.00	0.00	125.00	875.00	0.00	0.00	1000.00
5	0.00	0.00	0.00	125.00	375.00	0.00	0.00	500.00
6	0.00	0.00	0.00	125.00	875.00	0.00	0.00	1000.00
7	0.00	0.00	0.00	125.00	875.00	0.00	0.00	1000.00
8	0.00	0.00	0.00	125.00	875.00	0.00	0.00	1000.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= 0.00

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LOSS	PROFIT
1	125.00	0.00	1000.00	0.00	875.00	0.00	0.00	-15.98
2	125.00	0.00	1000.00	0.00	875.00	0.00	0.00	-16.10
3	125.00	0.00	1000.00	0.00	875.00	0.00	0.00	-18.00
4	125.00	0.00	1000.00	0.00	875.00	0.00	0.00	-26.95
5	125.00	0.00	500.00	0.00	375.00	0.00	0.00	-19.69
6	125.00	0.00	1000.00	0.00	875.00	0.00	0.00	-38.38
7	125.00	0.00	1000.00	0.00	875.00	0.00	0.00	-28.68
8	125.00	0.00	1000.00	0.00	875.00	0.00	0.00	-21.20

NET COST FOR SPPF = 184.97

TABLE 4.

EXAMPLE 5(B) - OPTIMUM SCHEDULING: SHIFTABLE LOADS

IOPT= 3 DT= 3.00 N= 8
R1= 100.00 R2= 100.00 S= 0.00 EPS= .800 DEL= .800
UT= 7500.00 UL= 400.00 UH= 1000.00

K	P(K)	Q(K)	R(K)	G(K)
1	.0138	.0168	.0100	900.00
2	.0139	.0170	.0100	900.00
3	.0157	.0191	.0100	900.00
4	.0240	.0294	.0100	900.00
5	.0402	.0492	.0100	900.00
6	.0347	.0424	.0100	900.00
7	.0257	.0314	.0100	900.00
8	.0187	.0228	.0100	900.00

XO= 0.00 REVENUE= -73.58 ERROR= 0

K PERIOD	1	2	3	4	5	6	7	8
1	0.00	0.00	0.00	900.00	100.00	0.00	0.00	1000.00
2	0.00	0.00	0.00	900.00	100.00	0.00	0.00	1000.00
3	0.00	0.00	0.00	900.00	100.00	0.00	0.00	1000.00
4	0.00	0.00	0.00	900.00	100.00	0.00	0.00	1000.00
5	0.00	0.00	300.00	600.00	0.00	0.00	0.00	600.00
6	0.00	0.00	0.00	900.00	0.00	0.00	0.00	900.00
7	0.00	0.00	0.00	900.00	100.00	0.00	0.00	1000.00
8	0.00	0.00	0.00	900.00	100.00	0.00	0.00	1000.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= 0.00

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LOSS	PROFIT
1	900.00	0.00	1000.00	0.00	100.00	0.00	0.00	-10.68
2	900.00	0.00	1000.00	0.00	100.00	0.00	0.00	-10.70
3	900.00	0.00	1000.00	0.00	100.00	0.00	0.00	-10.91
4	900.00	0.00	1000.00	0.00	100.00	0.00	0.00	-11.94
5	900.00	0.00	600.00	300.00	0.00	0.00	0.00	3.07
6	900.00	0.00	900.00	0.00	0.00	0.00	0.00	-9.00
7	900.00	0.00	1000.00	0.00	100.00	0.00	0.00	-12.14
8	900.00	0.00	1000.00	0.00	100.00	0.00	0.00	-11.28

NET COST FOR SPPF = 73.58

TABLE 5.

EXAMPLE 1(C) - OPTIMUM SCHEDULING: DEPENDENT-GENERATION

IOPT= 5 DT= 3.00 N= 8
R1= 100.00 R2= 100.00 S= 0.00 EPS= .800 DEL= .800 BETA= .850
UT= 7500.00 UL= 400.00 UH= 1000.00

K	P(K)	Q(K)	R(K)	G(K)
1	.0138	.0168	.0100	125.00
2	.0139	.0170	.0100	125.00
3	.0157	.0191	.0100	125.00
4	.0240	.0294	.0100	125.00
5	.0402	.0492	.0100	125.00
6	.0347	.0424	.0100	125.00
7	.0257	.0314	.0100	125.00
8	.0187	.0228	.0100	125.00

XO= 0.00 REVENUE= -43.46 ERROR= 0

K PERIOD	1	2	3	4	5	6	7	8	9	10
1	0.00	0.00	0.00	125.00	875.00	.00	0.00	1000.00	0.00	850.00
2	0.00	0.00	0.00	125.00	875.00	.00	0.00	1000.00	0.00	850.00
3	0.00	0.00	0.00	125.00	875.00	0.00	0.00	1000.00	.00	850.00
4	0.00	0.00	0.00	125.00	875.00	.00	0.00	1000.00	0.00	850.00
5	0.00	0.00	0.00	125.00	375.00	0.00	0.00	500.00	.00	425.00
6	0.00	0.00	0.00	125.00	875.00	0.00	0.00	1000.00	.00	850.00
7	0.00	0.00	0.00	125.00	875.00	-.00	0.00	1000.00	0.00	850.00
8	0.00	0.00	0.00	125.00	875.00	.00	0.00	1000.00	0.00	850.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= 0.00

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LOSS	PROFIT
1	125.00	850.00	1000.00	850.00	875.00	-.00	.00	-4.27
2	125.00	850.00	1000.00	850.00	875.00	-.00	.00	-4.29
3	125.00	850.00	1000.00	850.00	875.00	.00	.00	-4.69
4	125.00	850.00	1000.00	850.00	875.00	-.00	.00	-6.52
5	125.00	425.00	500.00	425.00	375.00	.00	.00	-2.59
6	125.00	850.00	1000.00	850.00	875.00	.00	.00	-8.87
7	125.00	850.00	1000.00	850.00	875.00	.00	-.00	-6.88
8	125.00	850.00	1000.00	850.00	875.00	-.00	.00	-5.34

NET COST FOR SPPF = 43.46

TABLE 6.

EXAMPLE 5(C) - OPTIMUM SCHEDULING: DEPENDENT-GENERATION

IOPT= 5 DT= 3.00 N= 8
R1= 100.00 R2= 100.00 S= 0.00 EPS= .800 DEL= .800 BETA= .850
UT= 7500.00 UL= 400.00 UH= 1000.00

K	P(K)	Q(K)	R(K)	G(K)
1	.0138	.0168	.0100	900.00
2	.0139	.0170	.0100	900.00
3	.0157	.0191	.0100	900.00
4	.0240	.0294	.0100	900.00
5	.0402	.0492	.0100	900.00
6	.0347	.0424	.0100	900.00
7	.0257	.0314	.0100	900.00
8	.0187	.0228	.0100	900.00

XO= 0.00 REVENUE= 69.14 ERROR= 0

K PERIOD	1	2	3	4	5	6	7	8	9	10
1	0.00	0.00	0.00	900.00	100.00	0.00	0.00	1000.00	.00	850.00
2	0.00	0.00	0.00	900.00	100.00	0.00	0.00	1000.00	.00	850.00
3	0.00	0.00	0.00	900.00	100.00	0.00	0.00	1000.00	.00	850.00
4	0.00	0.00	0.00	900.00	0.00	-.00	0.00	900.00	0.00	765.00
5	0.00	0.00	0.00	900.00	0.00	0.00	0.00	900.00	.00	765.00
6	0.00	0.00	0.00	900.00	0.00	0.00	0.00	900.00	.00	765.00
7	0.00	0.00	0.00	900.00	0.00	.00	0.00	900.00	0.00	765.00
8	0.00	0.00	0.00	900.00	.00	.00	0.00	900.00	0.00	765.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= 0.00

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LOSS	PROFIT
1	900.00	850.00	1000.00	850.00	100.00	.00	.00	1.02
2	900.00	850.00	1000.00	850.00	100.00	.00	.00	1.11
3	900.00	850.00	1000.00	850.00	100.00	.00	.00	2.40
4	900.00	765.00	900.00	765.00	0.00	.00	-.00	9.38
5	900.00	765.00	900.00	765.00	0.00	.00	.00	21.78
6	900.00	765.00	900.00	765.00	0.00	.00	.00	17.55
7	900.00	765.00	900.00	765.00	0.00	-.00	.00	10.62
8	900.00	765.00	900.00	765.00	.00	-.00	.00	5.27

NET REVENUE FOR SPPF = 69.14

TABLE 7.

EXAMPLE 2(A) - OPTIMUM STORAGE CAPACITY: FIXED LOADS

IOPT= 1 DT= 3.00 N= 8
R1= 100.00 R2= 100.00 ALFA= 0.00000 EPS= .800 DEL= .800

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	.0138	.0168	.0100	125.00	975.96
2	.0139	.0170	.0100	125.00	970.56
3	.0157	.0191	.0100	125.00	949.68
4	.0240	.0294	.0100	125.00	915.84
5	.0402	.0492	.0100	125.00	921.24
6	.0347	.0424	.0100	125.00	889.56
7	.0257	.0314	.0100	125.00	903.96
8	.0187	.0228	.0100	125.00	904.68

XO= 0.00 REVENUE= -181.82 ERROR= 0

K PERIOD	1	2	3	4	5	6	7
1	250.00	125.00	0.00	0.00	975.96	0.00	0.00
2	250.00	125.00	0.00	0.00	970.56	0.00	0.00
3	250.00	125.00	0.00	0.00	949.68	0.00	0.00
4	0.00	0.00	0.00	125.00	790.84	0.00	0.00
5	0.00	0.00	0.00	125.00	556.24	240.00	0.00
6	0.00	0.00	0.00	125.00	524.56	240.00	0.00
7	0.00	0.00	0.00	125.00	538.96	240.00	0.00
8	0.00	0.00	0.00	125.00	779.68	0.00	0.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= 0.00
OPTIMUM STORAGE CAPACITY= 900.00

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LOSS	PROFIT
1	125.00	0.00	975.96	0.00	1225.96	300.00	75.00	-21.88
2	125.00	0.00	970.56	0.00	1220.56	300.00	75.00	-21.96
3	125.00	0.00	949.68	0.00	1199.68	300.00	75.00	-24.21
4	125.00	0.00	915.84	0.00	790.84	0.00	0.00	-24.48
5	125.00	0.00	921.24	0.00	556.24	-300.00	60.00	-28.60
6	125.00	0.00	889.56	0.00	524.56	-300.00	60.00	-23.51
7	125.00	0.00	903.96	0.00	538.96	-300.00	60.00	-18.15
8	125.00	0.00	904.68	0.00	779.68	0.00	0.00	-19.03

NET COST FOR SPPF = 181.82

TABLE 8.

EXAMPLE 5(D) - OPTIMUM STORAGE CAPACITY: FIXED LOADS

IOPT= 1 DT= 3.00 N= 8
R1= 100.00 R2= 100.00 ALFA= 0.00000 EPS= .800 DEL= .800

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	.0138	.0168	.0100	900.00	975.96
2	.0139	.0170	.0100	900.00	970.56
3	.0157	.0191	.0100	900.00	949.68
4	.0240	.0294	.0100	900.00	915.84
5	.0402	.0492	.0100	900.00	921.24
6	.0347	.0424	.0100	900.00	889.56
7	.0257	.0314	.0100	900.00	903.96
8	.0187	.0228	.0100	900.00	904.68

XO= 0.00 REVENUE= -71.30 ERROR= 0

K PERIOD	1	2	3	4	5	6	7
1	0.00	375.00	0.00	525.00	450.96	0.00	0.00
2	0.00	375.00	0.00	525.00	445.56	0.00	0.00
3	0.00	6.19	0.00	893.81	55.87	0.00	0.00
4	0.00	0.00	0.00	900.00	15.84	0.00	0.00
5	0.00	0.00	218.76	681.24	0.00	240.00	0.00
6	0.00	0.00	250.44	649.56	0.00	240.00	0.00
7	0.00	0.00	0.00	900.00	0.00	3.96	0.00
8	0.00	0.00	0.00	900.00	4.68	0.00	0.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= 0.00
OPTIMUM STORAGE CAPACITY= 604.95

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LOSS	PROFIT
1	900.00	0.00	975.96	0.00	450.96	300.00	75.00	-16.59
2	900.00	0.00	970.56	0.00	445.56	300.00	75.00	-16.56
3	900.00	0.00	949.68	0.00	55.87	4.95	1.24	-10.07
4	900.00	0.00	915.84	0.00	15.84	0.00	0.00	-9.47
5	900.00	0.00	921.24	218.76	0.00	-300.00	60.00	-.20
6	900.00	0.00	889.56	250.44	0.00	-300.00	60.00	-.31
7	900.00	0.00	903.96	0.00	0.00	-4.95	.99	-9.00
8	900.00	0.00	904.68	0.00	4.68	0.00	0.00	-9.11

NET COST FOR SPPF = 71.30

TABLE 9.

EXAMPLE 2(A1) - OPTIMUM SCHEDULING:
CHECKING OPTIMUM STORAGE CAPACITY OF EXAMPLE 2(A)

IOPT= 1 DT= 3.00 N= 8
R1= 100.00 R2= 100.00 S= 1200.00 EPS= .800 DEL= .800

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	.0138	.0168	.0100	125.00	975.96
2	.0139	.0170	.0100	125.00	970.56
3	.0157	.0191	.0100	125.00	949.68
4	.0240	.0294	.0100	125.00	915.84
5	.0402	.0492	.0100	125.00	921.24
6	.0347	.0424	.0100	125.00	889.56
7	.0257	.0314	.0100	125.00	903.96
8	.0187	.0228	.0100	125.00	904.68

XO= 0.00 REVENUE= -181.82 ERROR= 0

PERIOD \ K	1	2	3	4	5	6	7
1	250.00	125.00	0.00	0.00	975.96	0.00	0.00
2	250.00	125.00	0.00	0.00	970.56	0.00	0.00
3	250.00	125.00	0.00	0.00	949.68	0.00	0.00
4	0.00	0.00	0.00	125.00	790.84	0.00	0.00
5	0.00	0.00	0.00	125.00	556.24	240.00	0.00
6	0.00	0.00	0.00	125.00	524.56	240.00	0.00
7	0.00	0.00	0.00	125.00	538.96	240.00	0.00
8	0.00	0.00	0.00	125.00	779.68	0.00	0.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= 0.00

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LOSS	PROFIT
1	125.00	0.00	975.96	0.00	1225.96	300.00	75.00	-21.88
2	125.00	0.00	970.56	0.00	1220.56	300.00	75.00	-21.96
3	125.00	0.00	949.68	0.00	1199.68	300.00	75.00	-24.21
4	125.00	0.00	915.84	0.00	790.84	0.00	0.00	-24.48
5	125.00	0.00	921.24	0.00	556.24	-300.00	60.00	-28.60
6	125.00	0.00	889.56	0.00	524.56	-300.00	60.00	-23.51
7	125.00	0.00	903.96	0.00	538.96	-300.00	60.00	-18.15
8	125.00	0.00	904.68	0.00	779.68	0.00	0.00	-19.03

NET COST FOR SPPF = 181.82

TABLE 10.

EXAMPLE 5(G) - OPTIMUM STORAGE CAPACITY:
EFFECT OF NONZERO STORAGE COST FOR EXAMPLE 5(D)

IOPT= 1 DT= 3.00 N= 8
R1= 100.00 R2= 100.00 ALFA= .00010 EPS= .800 DEL= .800

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	.0138	.0168	.0100	900.00	975.96
2	.0139	.0170	.0100	900.00	970.56
3	.0157	.0191	.0100	900.00	949.68
4	.0240	.0294	.0100	900.00	915.84
5	.0402	.0492	.0100	900.00	921.24
6	.0347	.0424	.0100	900.00	889.56
7	.0257	.0314	.0100	900.00	903.96
8	.0187	.0228	.0100	900.00	904.68

XO= 0.00 REVENUE= -72.74 ERROR= 0

K / PERIOD	1	2	3	4	5	6	7
1	0.00	375.00	0.00	525.00	450.96	0.00	0.00
2	0.00	375.00	0.00	525.00	445.56	0.00	0.00
3	0.00	.00	0.00	900.00	49.68	0.00	0.00
4	0.00	0.00	0.00	900.00	15.84	0.00	0.00
5	0.00	0.00	218.76	681.24	0.00	240.00	0.00
6	0.00	0.00	250.44	649.56	0.00	240.00	0.00
7	0.00	0.00	0.00	900.00	3.96	0.00	0.00
8	0.00	0.00	0.00	900.00	4.68	0.00	0.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= 0.00
OPTIMUM STORAGE CAPACITY= 600.00

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LOSS	PROFIT
1	900.00	0.00	975.96	0.00	450.96	300.00	75.00	-16.59
2	900.00	0.00	970.56	0.00	445.56	300.00	75.00	-16.56
3	900.00	0.00	949.68	0.00	49.68	.00	.00	-9.95
4	900.00	0.00	915.84	0.00	15.84	0.00	0.00	-9.47
5	900.00	0.00	921.24	218.76	0.00	-300.00	60.00	-.20
6	900.00	0.00	889.56	250.44	0.00	-300.00	60.00	-.31
7	900.00	0.00	903.96	0.00	3.96	0.00	0.00	-9.12
8	900.00	0.00	904.68	0.00	4.68	0.00	0.00	-9.11

NET COST FOR SPPF = 72.74

TABLE 11.

EXAMPLE 5(H) - OPTIMUM STORAGE CAPACITY:
EFFECT OF NONZERO STORAGE COST FOR EXAMPLE 5(D)

IOPT= 1 DT= 3.00 N= 8
R1= 100.00 R2= 100.00 ALFA= .00050 EPS= .800 DEL= .800

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	.0138	.0168	.0100	900.00	975.96
2	.0139	.0170	.0100	900.00	970.56
3	.0157	.0191	.0100	900.00	949.68
4	.0240	.0294	.0100	900.00	915.84
5	.0402	.0492	.0100	900.00	921.24
6	.0347	.0424	.0100	900.00	889.56
7	.0257	.0314	.0100	900.00	903.96
8	.0187	.0228	.0100	900.00	904.68

XO= 0.00 REVENUE= -76.64 ERROR= 0

PERIOD \ K	1	2	3	4	5	6	7
1	0.00	33.19	0.00	866.81	109.15	0.00	0.00
2	0.00	.00	0.00	900.00	70.56	0.00	0.00
3	0.00	.00	0.00	900.00	49.68	0.00	0.00
4	0.00	0.00	0.00	900.00	15.84	0.00	0.00
5	0.00	0.00	0.00	900.00	0.00	21.24	0.00
6	0.00	0.00	10.44	889.56	0.00	0.00	0.00
7	0.00	0.00	0.00	900.00	3.96	0.00	0.00
8	0.00	0.00	0.00	900.00	4.68	0.00	0.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= 0.00
OPTIMUM STORAGE CAPACITY= 26.55

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LOSS	PROFIT
1	900.00	0.00	975.96	0.00	109.15	26.55	6.64	-10.84
2	900.00	0.00	970.56	0.00	70.56	.00	.00	-10.20
3	900.00	0.00	949.68	0.00	49.68	.00	.00	-9.95
4	900.00	0.00	915.84	0.00	15.84	0.00	0.00	-9.47
5	900.00	0.00	921.24	0.00	0.00	-26.55	5.31	-9.00
6	900.00	0.00	889.56	10.44	0.00	0.00	0.00	-8.64
7	900.00	0.00	903.96	0.00	3.96	0.00	0.00	-9.12
8	900.00	0.00	904.68	0.00	4.68	0.00	0.00	-9.11

NET COST FOR SPPF = 76.64

TABLE 12.

EXAMPLE 2(B) - OPTIMUM STORAGE CAPACITY: SHIFTABLE LOADS

IOPT= 3 DT= 3.00 N= 8
R1= 100.00 R2= 100.00 ALFA= 0.00000 EPS= .800 DEL= .800
UT= 7500.00 UL= 400.00 UH= 1000.00

K	P(K)	Q(K)	R(K)	G(K)
1	.0138	.0168	.0100	125.00
2	.0139	.0170	.0100	125.00
3	.0157	.0191	.0100	125.00
4	.0240	.0294	.0100	125.00
5	.0402	.0492	.0100	125.00
6	.0347	.0424	.0100	125.00
7	.0257	.0314	.0100	125.00
8	.0187	.0228	.0100	125.00

XO= 0.00 REVENUE= -175.31 ERROR= 0

K / PERIOD	1	2	3	4	5	6	7	8
1	250.00	125.00	0.00	0.00	1000.00	0.00	0.00	1000.00
2	250.00	125.00	0.00	0.00	1000.00	0.00	0.00	1000.00
3	250.00	125.00	0.00	0.00	1000.00	0.00	0.00	1000.00
4	0.00	0.00	0.00	125.00	875.00	0.00	0.00	1000.00
5	0.00	0.00	0.00	125.00	135.00	240.00	0.00	500.00
6	0.00	0.00	0.00	125.00	635.00	240.00	0.00	1000.00
7	0.00	0.00	0.00	125.00	635.00	240.00	0.00	1000.00
8	0.00	0.00	0.00	125.00	875.00	0.00	0.00	1000.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= 0.00
OPTIMUM STORAGE CAPACITY= 900.00

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LOSS	PROFIT
1	125.00	0.00	1000.00	0.00	1250.00	300.00	75.00	-22.29
2	125.00	0.00	1000.00	0.00	1250.00	300.00	75.00	-22.46
3	125.00	0.00	1000.00	0.00	1250.00	300.00	75.00	-25.18
4	125.00	0.00	1000.00	0.00	875.00	0.00	0.00	-26.95
5	125.00	0.00	500.00	0.00	135.00	-300.00	60.00	-7.89
6	125.00	0.00	1000.00	0.00	635.00	-300.00	60.00	-28.19
7	125.00	0.00	1000.00	0.00	635.00	-300.00	60.00	-21.16
8	125.00	0.00	1000.00	0.00	875.00	0.00	0.00	-21.20

NET COST FOR SPPF = 175.31

TABLE 13.

EXAMPLE 5(E) - OPTIMUM STORAGE CAPACITY: SHIFTABLE LOADS

IOPT= 3 DT= 3.00 N= 8
R1= 100.00 R2= 100.00 ALFA= 0.00000 EPS= .800 DEL= .800
UT= 7500.00 UL= 400.00 UH= 1000.00

K	P(K)	Q(K)	R(K)	G(K)
1	.0138	.0168	.0100	900.00
2	.0139	.0170	.0100	900.00
3	.0157	.0191	.0100	900.00
4	.0240	.0294	.0100	900.00
5	.0402	.0492	.0100	900.00
6	.0347	.0424	.0100	900.00
7	.0257	.0314	.0100	900.00
8	.0187	.0228	.0100	900.00

XO= 0.00 REVENUE= -67.57 ERROR= 0

K PERIOD	1	2	3	4	5	6	7	8
1	0.00	375.00	0.00	525.00	475.00	0.00	0.00	1000.00
2	0.00	375.00	0.00	525.00	475.00	0.00	0.00	1000.00
3	0.00	156.25	0.00	743.75	256.25	0.00	0.00	1000.00
4	0.00	0.00	0.00	900.00	100.00	0.00	0.00	1000.00
5	0.00	0.00	640.00	260.00	0.00	240.00	0.00	500.00
6	0.00	0.00	140.00	760.00	0.00	240.00	0.00	1000.00
7	0.00	0.00	0.00	900.00	0.00	100.00	0.00	1000.00
8	0.00	0.00	0.00	900.00	100.00	0.00	0.00	1000.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= 0.00
OPTIMUM STORAGE CAPACITY= 725.00

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LOSS	PROFIT
1	900.00	0.00	1000.00	0.00	475.00	300.00	75.00	-16.99
2	900.00	0.00	1000.00	0.00	475.00	300.00	75.00	-17.06
3	900.00	0.00	1000.00	0.00	256.25	125.00	31.25	-13.90
4	900.00	0.00	1000.00	0.00	100.00	0.00	0.00	-11.94
5	900.00	0.00	500.00	640.00	0.00	-300.00	60.00	16.75
6	900.00	0.00	1000.00	140.00	0.00	-300.00	60.00	-4.14
7	900.00	0.00	1000.00	0.00	0.00	-125.00	25.00	-9.00
8	900.00	0.00	1000.00	0.00	100.00	0.00	0.00	-11.28

NET COST FOR SPPF = 67.57

TABLE 14.

EXAMPLE 2(C) - OPTIMUM STORAGE CAPACITY: DEPENDENT-GENERATION

IOPT= 5 DT= 3.00 N= 8
R1= 100.00 R2= 100.00 ALFA= 0.00000 EPS= .800 DEL= .800 BETA= .850
UT= 7500.00 UL= 400.00 UH= 1000.00

K	P(K)	Q(K)	R(K)	G(K)
1	.0138	.0168	.0100	125.00
2	.0139	.0170	.0100	125.00
3	.0157	.0191	.0100	125.00
4	.0240	.0294	.0100	125.00
5	.0402	.0492	.0100	125.00
6	.0347	.0424	.0100	125.00
7	.0257	.0314	.0100	125.00
8	.0187	.0228	.0100	125.00

XO= 300.00 REVENUE= -30.14 ERROR= 0

K PERIOD	1	2	3	4	5	6	7	8	9	10
1	0.00	0.00	0.00	125.00	875.00	0.00	0.00	1000.00	375.00	475.00
2	0.00	0.00	0.00	125.00	875.00	0.00	0.00	1000.00	375.00	475.00
3	0.00	0.00	0.00	125.00	875.00	0.00	0.00	1000.00	375.00	475.00
4	0.00	0.00	0.00	125.00	635.00	240.00	0.00	1000.00	0.00	850.00
5	0.00	0.00	0.00	125.00	135.00	240.00	0.00	500.00	0.00	425.00
6	0.00	0.00	0.00	125.00	635.00	240.00	0.00	1000.00	0.00	850.00
7	0.00	0.00	0.00	125.00	635.00	240.00	0.00	1000.00	0.00	850.00
8	0.00	0.00	0.00	125.00	875.00	0.00	0.00	1000.00	375.00	475.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= 300.00
OPTIMUM STORAGE CAPACITY= 1200.00

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LOSS	PROFIT
1	125.00	850.00	1000.00	475.00	875.00	300.00	75.00	-9.44
2	125.00	850.00	1000.00	475.00	875.00	300.00	75.00	-9.50
3	125.00	850.00	1000.00	475.00	875.00	300.00	75.00	-10.56
4	125.00	850.00	1000.00	850.00	635.00	-300.00	60.00	.53
5	125.00	425.00	500.00	425.00	135.00	-300.00	60.00	9.21
6	125.00	850.00	1000.00	850.00	635.00	-300.00	60.00	1.31
7	125.00	850.00	1000.00	850.00	635.00	-300.00	60.00	.65
8	125.00	850.00	1000.00	475.00	875.00	300.00	75.00	-12.34

NET COST FOR SPPF = 30.14

TABLE 15.

EXAMPLE 5(F) - OPTIMUM STORAGE CAPACITY: DEPENDENT-GENERATION

IOPT= 5 DT= 3.00 N= 8
R1= 100.00 R2= 100.00 ALFA= 0.00000 EPS= .800 DEL= .800 BETA= .850
UT= 7500.00 UL= 400.00 UH= 1000.00

K	P(K)	Q(K)	R(K)	G(K)
1	.0138	.0168	.0100	900.00
2	.0139	.0170	.0100	900.00
3	.0157	.0191	.0100	900.00
4	.0240	.0294	.0100	900.00
5	.0402	.0492	.0100	900.00
6	.0347	.0424	.0100	900.00
7	.0257	.0314	.0100	900.00
8	.0187	.0228	.0100	900.00

XO= .00 REVENUE= 77.42 ERROR= 0

K PERIOD	1	2	3	4	5	6	7	8	9	10
1	0.00	0.00	0.00	900.00	100.00	0.00	0.00	1000.00	375.00	475.00
2	0.00	0.00	0.00	900.00	100.00	0.00	0.00	1000.00	375.00	475.00
3	0.00	0.00	0.00	900.00	100.00	0.00	0.00	1000.00	375.00	475.00
4	0.00	0.00	0.00	900.00	0.00	100.00	0.00	1000.00	0.00	850.00
5	0.00	0.00	300.00	600.00	0.00	0.00	240.00	600.00	0.00	510.00
6	0.00	0.00	0.00	900.00	0.00	100.00	140.00	1000.00	0.00	850.00
7	0.00	0.00	0.00	900.00	0.00	100.00	40.00	1000.00	0.00	850.00
8	0.00	0.00	0.00	900.00	0.00	0.00	0.00	900.00	0.00	765.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= .00
OPTIMUM STORAGE CAPACITY= 900.00

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LOSS	PROFIT
1	900.00	850.00	1000.00	475.00	100.00	300.00	75.00	-4.14
2	900.00	850.00	1000.00	475.00	100.00	300.00	75.00	-4.10
3	900.00	850.00	1000.00	475.00	100.00	300.00	75.00	-3.48
4	900.00	850.00	1000.00	850.00	0.00	-125.00	25.00	11.43
5	900.00	510.00	600.00	1050.00	0.00	-300.00	60.00	33.24
6	900.00	850.00	1000.00	990.00	0.00	-300.00	60.00	25.36
7	900.00	850.00	1000.00	890.00	0.00	-175.00	35.00	13.83
8	900.00	765.00	900.00	765.00	0.00	0.00	0.00	5.27

NET REVENUE FOR SPPF = 77.42

TABLE 16.

EXAMPLE 3(A) - OPTIMUM PRICING: SCHEDULE OF EXAMPLE 2(A)

IOPT= 1 DT= 3.00 N= 8
R1= 100.00 R2= 100.00 S= 900.00 EPS= .800 DEL= .800

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	.0138	.0168	.0100	125.00	975.96
2	.0139	.0170	.0100	125.00	970.56
3	.0157	.0191	.0100	125.00	949.68
4	.0240	.0294	.0100	125.00	915.84
5	.0402	.0492	.0100	125.00	921.24
6	.0347	.0424	.0100	125.00	889.56
7	.0257	.0314	.0100	125.00	903.96
8	.0187	.0228	.0100	125.00	904.68

** OPTIMUM PRICES **

K	P(K)	Q(K)
1	.0138	.0270
2	.0283	.0315
3	.0283	.0315
4	.0443	.0492
5	.0138	.0492
6	.0138	.0492
7	.0138	.0492
8	.0443	.0492

** MODIFIED OPTIMUM PRICES **

K	P(K)	Q(K)
1	.0246	.0274
2	.0269	.0298
3	.0278	.0308
4	.0425	.0472
5	.0138	.0492
6	.0138	.0492
7	.0138	.0482
8	.0425	.0472

TABLE 17.

EXAMPLE 5(H) - OPTIMUM PRICING:
OPTIMUM PRICES FOR EXAMPLE 5(D)

IOPT= 1 DT= 3.00 N= 8
R1= 100.00 R2= 100.00 S= 604.95 EPS= .800 DEL= .800

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	.0138	.0168	.0100	900.00	975.96
2	.0139	.0170	.0100	900.00	970.56
3	.0157	.0191	.0100	900.00	949.68
4	.0240	.0294	.0100	900.00	915.84
5	.0402	.0492	.0100	900.00	921.24
6	.0347	.0424	.0100	900.00	889.56
7	.0257	.0314	.0100	900.00	903.96
8	.0187	.0228	.0100	900.00	904.68

** OPTIMUM PRICES **

K	P(K)	Q(K)
1	.0255	.0283
2	.0138	.0283
3	.0255	.0283
4	.0399	.0443
5	.0443	.0492
6	.0443	.0492
7	.0138	.0443
8	.0399	.0443

** MODIFIED OPTIMUM PRICES **

K	P(K)	Q(K)
1	.0235	.0261
2	.0235	.0261
3	.0138	.0271
4	.0138	.0423
5	.0443	.0492
6	.0443	.0492
7	.0138	.0433
8	.0381	.0423

TABLE 18.

EXAMPLE 3(B) - OPTIMUM PRICING:
CHECKING OPTIMUM PRICES OF EXAMPLE 3(A)

IOPT= 1 DT= 3.00 N= 8
R1= 100.00 R2= 100.00 S= 900.00 EPS= .800 DEL= .300

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	.0138	.0270	.0100	125.00	975.96
2	.0283	.0315	.0100	125.00	970.56
3	.0283	.0315	.0100	125.00	949.68
4	.0443	.0492	.0100	125.00	915.84
5	.0138	.0492	.0100	125.00	921.24
6	.0138	.0492	.0100	125.00	889.56
7	.0138	.0492	.0100	125.00	903.96
8	.0443	.0492	.0100	125.00	904.68

XO= 0.00 REVENUE= -276.29 ERROR= 0

K / PERIOD	1	2	3	4	5	6	7
1	250.00	125.00	0.00	0.00	975.96	0.00	0.00
2	0.00	0.00	0.00	125.00	845.56	0.00	0.00
3	0.00	0.00	0.00	125.00	824.68	0.00	0.00
4	0.00	0.00	0.00	125.00	550.84	240.00	0.00
5	0.00	0.00	0.00	125.00	796.24	0.00	0.00
6	0.00	0.00	0.00	125.00	764.56	0.00	0.00
7	0.00	0.00	0.00	125.00	778.96	0.00	0.00
8	0.00	0.00	0.00	125.00	779.68	0.00	0.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= 0.00

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LOSS	PROFIT
1	125.00	0.00	975.96	0.00	1225.96	300.00	75.00	-34.35
2	125.00	0.00	970.56	0.00	845.56	0.00	0.00	-27.89
3	125.00	0.00	949.68	0.00	824.68	0.00	0.00	-27.23
4	125.00	0.00	915.84	0.00	550.84	-300.00	60.00	-28.35
5	125.00	0.00	921.24	0.00	796.24	0.00	0.00	-40.43
6	125.00	0.00	889.56	0.00	764.56	0.00	0.00	-38.87
7	125.00	0.00	903.96	0.00	778.96	0.00	0.00	-39.57
8	125.00	0.00	904.68	0.00	779.68	0.00	0.00	-39.61

NET COST FOR SPPF = 276.29

TABLE 19.

EXAMPLE 5(I) : OPTIMUM SCHEDULING:
CHECKING OPTIMUM PRICES OF EXAMPLE 5(H)

IOPT= 1 DT= 3.00 N= 8
R1= 100.00 R2= 100.00 S= 604.95 EPS= .800 DEL= .800

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	.0255	.0283	.0100	900.00	975.96
2	.0138	.0283	.0100	900.00	970.56
3	.0255	.0283	.0100	900.00	949.68
4	.0399	.0443	.0100	900.00	915.84
5	.0443	.0492	.0100	900.00	921.24
6	.0443	.0492	.0100	900.00	889.56
7	.0138	.0443	.0100	900.00	903.96
8	.0399	.0443	.0100	900.00	904.68

XO= 0.00 REVENUE= -79.08 ERROR= 0

K PERIOD	1	2	3	4	5	6	7
1	0.00	375.00	0.00	525.00	450.96	0.00	0.00
2	0.00	375.00	0.00	525.00	445.56	0.00	0.00
3	0.00	6.19	0.00	893.81	55.87	0.00	0.00
4	0.00	0.00	0.00	900.00	0.00	15.84	0.00
5	0.00	0.00	218.76	681.24	0.00	240.00	0.00
6	0.00	0.00	238.56	661.44	0.00	228.12	0.00
7	0.00	0.00	0.00	900.00	3.96	0.00	0.00
8	0.00	0.00	0.00	900.00	4.68	0.00	0.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= 0.00

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LOSS	PROFIT
1	900.00	0.00	975.96	0.00	450.96	300.00	75.00	-21.76
2	900.00	0.00	970.56	0.00	445.56	300.00	75.00	-21.61
3	900.00	0.00	949.68	0.00	55.87	4.95	1.24	-10.58
4	900.00	0.00	915.84	0.00	0.00	-19.80	3.96	-9.00
5	900.00	0.00	921.24	218.76	0.00	-300.00	60.00	.69
6	900.00	0.00	889.56	238.56	0.00	-285.15	57.03	1.57
7	900.00	0.00	903.96	0.00	3.96	0.00	0.00	-9.18
8	900.00	0.00	904.68	0.00	4.68	0.00	0.00	-9.21

NET COST FOR SPPF = 79.08

TABLE 20.

EXAMPLE 3(C) - OPTIMUM PRICING:
CHECKING MODIFIED OPTIMUM PRICES OF EXAMPLE 3(A)

IOPT= 1 DT= 3.00 N= 8
R1= 100.00 R2= 100.00 S= 900.00 EPS= .800 DEL= .800

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	.0249	.0274	.0100	125.00	975.96
2	.0269	.0298	.0100	125.00	970.56
3	.0278	.0308	.0100	125.00	949.68
4	.0425	.0472	.0100	125.00	915.84
5	.0138	.0492	.0100	125.00	921.24
6	.0138	.0492	.0100	125.00	889.56
7	.0138	.0492	.0100	125.00	903.96
8	.0425	.0472	.0100	125.00	904.68

XO= 0.00 REVENUE= -270.73 ERROR= 0

PERIOD \ K	1	2	3	4	5	6	7
1	250.00	125.00	0.00	0.00	975.96	0.00	0.00
2	250.00	125.00	0.00	0.00	970.56	0.00	0.00
3	250.00	125.00	0.00	0.00	949.68	0.00	0.00
4	0.00	0.00	0.00	125.00	790.84	0.00	0.00
5	0.00	0.00	0.00	125.00	556.24	240.00	0.00
6	0.00	0.00	0.00	125.00	524.56	240.00	0.00
7	0.00	0.00	0.00	125.00	538.96	240.00	0.00
8	0.00	0.00	0.00	125.00	779.68	0.00	0.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= 0.00

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LOSS	PROFIT
1	125.00	0.00	975.96	0.00	1225.96	300.00	75.00	-34.84
2	125.00	0.00	970.56	0.00	1220.56	300.00	75.00	-37.62
3	125.00	0.00	949.68	0.00	1199.68	300.00	75.00	-38.20
4	125.00	0.00	915.84	0.00	790.84	0.00	0.00	-38.58
5	125.00	0.00	921.24	0.00	556.24	-300.00	60.00	-28.62
6	125.00	0.00	889.56	0.00	524.56	-300.00	60.00	-27.06
7	125.00	0.00	903.96	0.00	538.96	-300.00	60.00	-27.77
8	125.00	0.00	904.68	0.00	779.68	0.00	0.00	-38.05

NET COST FOR SPPF = 270.73

TABLE 21.

EXAMPLE 5(J) - OPTIMUM SCHEDULING:
CHECKING MODIFIED OPTIMUM PRICES OF EXAMPLE 5(H)

IOPT= 1 DT= 3.00 N= 8
R1= 100.00 R2= 100.00 S= 604.95 EPS= .800 DEL= .800

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	.0235	.0261	.0100	900.00	975.96
2	.0235	.0261	.0100	900.00	970.56
3	.0138	.0271	.0100	900.00	949.68
4	.0138	.0423	.0100	900.00	915.84
5	.0443	.0492	.0100	900.00	921.24
6	.0443	.0492	.0100	900.00	889.56
7	.0138	.0433	.0100	900.00	903.96
8	.0381	.0423	.0100	900.00	904.68

XO= 0.00 REVENUE= -77.00 ERROR= 0

PERIOD \ K	1	2	3	4	5	6	7
1	0.00	375.00	0.00	525.00	450.96	0.00	0.00
2	0.00	375.00	0.00	525.00	445.56	0.00	0.00
3	0.00	6.19	0.00	893.81	55.87	0.00	0.00
4	0.00	0.00	0.00	900.00	15.84	0.00	0.00
5	0.00	0.00	218.76	681.24	0.00	240.00	0.00
6	0.00	0.00	250.44	649.56	0.00	240.00	0.00
7	0.00	0.00	0.00	900.00	0.00	3.96	0.00
8	0.00	0.00	0.00	900.00	4.68	0.00	0.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= 0.00

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LOSS	PROFIT
1	900.00	0.00	975.96	0.00	450.96	300.00	75.00	-20.77
2	900.00	0.00	970.56	0.00	445.56	300.00	75.00	-20.63
3	900.00	0.00	949.68	0.00	55.87	4.95	1.24	-10.51
4	900.00	0.00	915.84	0.00	15.84	0.00	0.00	-9.67
5	900.00	0.00	921.24	218.76	0.00	-300.00	60.00	.69
6	900.00	0.00	889.56	250.44	0.00	-300.00	60.00	2.09
7	900.00	0.00	903.96	0.00	0.00	-4.95	.99	-9.00
8	900.00	0.00	904.68	0.00	4.68	0.00	0.00	-9.20

NET COST FOR SPPF = 77.00

TABLE 22.

EXAMPLE 4(A) - OPTIMUM PRICING:
SCHEDULE CHANGE OF EXAMPLE 2(A).
REQUIREMENTS: NO ENERGY PURCHASE GREATER THAN 1000 (KWH).

IOPT= 1 DT= 3.00 N= 8
R1= 100.00 R2= 100.00 S= 1200.00 EPS= .800 DEL= .800

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	.0138	.0168	.0100	125.00	975.96
2	.0139	.0170	.0100	125.00	970.56
3	.0157	.0191	.0100	125.00	949.68
4	.0240	.0294	.0100	125.00	915.84
5	.0402	.0492	.0100	125.00	921.24
6	.0347	.0424	.0100	125.00	889.56
7	.0257	.0314	.0100	125.00	903.96
8	.0187	.0228	.0100	125.00	904.68

** OPTIMUM PRICES FOR SCHEDULE CHANGE **

K	P(K)	Q(K)
1	.0283	.0315
2	.0283	.0315
3	.0443	.0492
4	.0443	.0492
5	.0443	.0492
6	.0138	.0492
7	.0443	.0492
8	.0283	.0315

TABLE 23.

EXAMPLE 5(K) - OPTIMUM PRICING:
OPTIMUM PRICES FOR SCHEDULE CHANGE OF EXAMPLE 5(D)
REQUIREMENTS : NO PURCHASE GREATER THAN 1000 (KWH)
PLUS A MINIMUM SALE OF 100 (KWH) DURING INTERVALS 5AND 6

IOPT= 1 DT= 3.00 N= 8
R1= 100.00 R2= 100.00 S= 1200.00 EPS= .800 DEL= .800

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	.0138	.0168	.0100	900.00	975.96
2	.0139	.0170	.0100	900.00	970.56
3	.0157	.0191	.0100	900.00	949.68
4	.0240	.0294	.0100	900.00	915.84
5	.0402	.0492	.0100	900.00	921.24
6	.0347	.0424	.0100	900.00	889.56
7	.0257	.0314	.0100	900.00	903.96
8	.0187	.0228	.0100	900.00	904.68

** OPTIMUM PRICES FOR SCHEDULE CHANGE **

K	P(K)	Q(K)
1	.0255	.0283
2	.0255	.0283
3	.0255	.0283
4	.0399	.0443
5	.0443	.0492
6	.0443	.0492
7	.0138	.0443
8	.0399	.0443

TABLE 24.

EXAMPLE 4(B) - OPTIMUM SCHEDULING:
CHECKING OPTIMUM PRICES OF EXAMPLE 4(A)

IOPT= 1 DT= 3.00 N= 8
R1= 100.00 R2= 100.00 S= 1200.00 EPS= .800 DEL= .800

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	.0283	.0315	.0100	125.00	975.96
2	.0283	.0315	.0100	125.00	970.56
3	.0443	.0492	.0100	125.00	949.68
4	.0443	.0492	.0100	125.00	915.84
5	.0443	.0492	.0100	125.00	921.24
6	.0138	.0492	.0100	125.00	889.56
7	.0443	.0492	.0100	125.00	903.96
8	.0283	.0315	.0100	125.00	904.68

XO= 0.00 REVENUE= -282.60 ERROR= 0

K / PERIOD	1	2	3	4	5	6	7
1	0.00	0.00	0.00	125.00	850.96	0.00	0.00
2	0.00	0.00	0.00	125.00	845.56	0.00	0.00
3	0.00	0.00	0.00	125.00	824.68	0.00	0.00
4	0.00	0.00	0.00	125.00	790.84	0.00	0.00
5	0.00	0.00	0.00	125.00	796.24	0.00	0.00
6	0.00	0.00	0.00	125.00	764.56	0.00	0.00
7	0.00	0.00	0.00	125.00	778.96	0.00	0.00
8	0.00	0.00	0.00	125.00	779.68	0.00	0.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= 0.00

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LOSS	PROFIT
1	125.00	0.00	975.96	0.00	850.96	0.00	0.00	-28.06
2	125.00	0.00	970.56	0.00	845.56	0.00	0.00	-27.89
3	125.00	0.00	949.68	0.00	824.68	0.00	0.00	-41.82
4	125.00	0.00	915.84	0.00	790.84	0.00	0.00	-40.16
5	125.00	0.00	921.24	0.00	796.24	0.00	0.00	-40.43
6	125.00	0.00	889.56	0.00	764.56	0.00	0.00	-38.87
7	125.00	0.00	903.96	0.00	778.96	0.00	0.00	-39.57
8	125.00	0.00	904.68	0.00	779.68	0.00	0.00	-25.81

NET COST FOR SPPF = 282.60

TABLE 25.

EXAMPLE 5(L) - OPTIMUM SCHEDULING:
CHECKING OPTIMUM PRICES FOR EXAMPLE 5(K)

IOPT= 1 DT= 3.00 N= 8
R1= 100.00 R2= 100.00 S= 1200.00 EPS= .800 DEL= .800

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	.0255	.0283	.0100	900.00	975.96
2	.0255	.0283	.0100	900.00	970.56
3	.0255	.0283	.0100	900.00	949.68
4	.0399	.0443	.0100	900.00	915.84
5	.0443	.0492	.0100	900.00	921.24
6	.0443	.0492	.0100	900.00	889.56
7	.0138	.0443	.0100	900.00	903.96
8	.0399	.0443	.0100	900.00	904.68

XO= 0. REVENUE= -79.07 ERROR= 0

K / PERIOD	1	2	3	4	5	6	7
1	0.00	375.00	0.00	525.00	450.96	0.00	0.00
2	0.00	375.00	0.00	525.00	445.56	0.00	0.00
3	0.00	38.25	0.00	861.75	87.93	0.00	0.00
4	0.00	0.00	0.00	900.00	0.00	15.84	0.00
5	0.00	0.00	218.76	681.24	0.00	240.00	0.00
6	0.00	0.00	250.44	649.56	0.00	240.00	0.00
7	0.00	0.00	0.00	900.00	0.00	3.96	0.00
8	0.00	0.00	0.00	900.00	0.00	4.68	0.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= 0.00

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LOSS	PROFIT
1	900.00	0.00	975.96	0.00	450.96	300.00	75.00	-21.76
2	900.00	0.00	970.56	0.00	445.56	300.00	75.00	-21.61
3	900.00	0.00	949.68	0.00	87.93	30.60	7.65	-11.49
4	900.00	0.00	915.84	0.00	0.00	-19.80	3.96	-9.00
5	900.00	0.00	921.24	218.76	0.00	-300.00	60.00	.69
6	900.00	0.00	889.56	250.44	0.00	-300.00	60.00	2.09
7	900.00	0.00	903.96	0.00	0.00	-4.95	.99	-9.00
8	900.00	0.00	904.68	0.00	0.00	-5.85	1.17	-9.00

NET COST FOR SPPF = 79.07

CHAPTER 7

NUMERICAL RESULTS, TVA SYSTEM WIDE STUDY

7.1 INTRODUCTION AND PROBLEM STATEMENT

In this Section a system wide study will be described using data for the entire TVA system forecasted for Wednesday August 29, 1990. The results discussed here are partially based on the TSCH program.

7.2 SYSTEM DATA PROVIDED BY TVA

The following demand data was provided by TVA for August 29, 1990 and given in MW*1000 on an hourly basis:

0 - 1 AM	15.2	12 AM - 1 PM	20.3
1 - 2 AM	14.5	1 - 2 PM	21.0
2 - 3 AM	14.0	2 - 3 PM	21.6
3 - 4 AM	13.8	3 - 4 PM	22.0
4 - 5 AM	13.7	4 - 5 PM	22.1
5 - 6 AM	14.3	5 - 6 PM	21.9
6 - 7 AM	15.2	6 - 7 PM	21.7
7 - 8 AM	16.3	7 - 8 PM	20.9
8 - 9 AM	17.0	8 - 9 PM	19.9
9 - 10 AM	17.9	9 - 10 PM	18.8
10 - 11 AM	18.8	10 - 11 PM	17.5
11 - 12 AM	19.5	11 - 12 PM	16.2

This data was converted into MWh*1000 over 2 hour time intervals such that the 24 hour day was divided into 12 time intervals. The so-called "NON-SPPF" load was then arrived at by taking 85% of this input data, this is equivalent to saying that 15% of the total system load will be made up of SPPF's.

Also provided by TVA were the marginal costs for that same day, given in dollars/MWh:

0 - 1 AM	23.7	12 AM - 1 PM	42.2
1 - 2 AM	23.8	1 - 2 PM	58.5
2 - 3 AM	23.8	2 - 3 PM	72.1
3 - 4 AM	23.8	3 - 4 PM	80.6
4 - 5 AM	23.6	4 - 5 PM	83.6
5 - 6 AM	23.8	5 - 6 PM	77.0
6 - 7 AM	23.8	6 - 7 PM	73.7
7 - 8 AM	23.8	7 - 8 PM	53.0
8 - 9 AM	23.8	8 - 9 PM	38.9
9 - 10 AM	26.3	9 - 10 PM	35.8
10 - 11 AM	34.7	10 - 11 PM	24.7
11 - 12 AM	36.7	11 - 12 PM	23.8

These marginal costs were then averaged over each two hour time interval. The resulting two hour marginal costs were then multiplied by 1.1 to arrive at the of spot prices at which TVA would sell energy to the individual SPPF's, Q(K). The resulting two hour marginal costs were also multiplied by 0.9 to arrive at the set of spot prices at which TVA would purchase energy back from the individual SPPF's, P(K).

The following local SPPF generation costs was used: R(K) = 31.9$/MWh. This cost is based on the following facts:

- TVA has supplied an estimated operating and maintenance cost data of 18 - 20 $/MWh, 1985 data.
- TVA has supplied an estimated fuel cost of 7 -9 $/MWh, 1985 data and based on cogeneration for a particular industrial customer within TVA's service area.
- The depreciation costs were not taken into account for this computation.
- The resulting average local SPPF generation cost of 25$/MWh was then used for 1985.
- An average escalation rate of 5% was then used for each of the five years between 1985 and 1990. This yields a multiplication factor of 1.276.
- The final local SPPF generation cost of 31.9$/MWh is then arrived at as: 25 * 1.276

TVA also supplied the data that for 1990 its required energy charge would be 51.1$/MWh. This value is used to compute the revenue generated from the NON-SPPF system load (85% of the actual total system load).

7.3 OTHER BASIC INPUT DATA

The on-site energy storage facility was assumed to be electrical batteries. Their charging and discharging efficiencies were set at EPS = 82% and DEL = 82%.

The various electrical line efficiencies for lines 3, 5, and 10 (see Figure 1) were all set to GAMMA = 96%.

The energy depletion efficiency in the energy storage device was set to MEU = 96% from one time interval to the next (i.e. during each two hour period the energy loss was assumed to be 4%, this is probably rather high)

For the SPPF's were shiftable load models are used, two different types of scheduling flexibility was assumed:

- UH/UL = 100%/75%, low flexibility.
- UH/UL = 100%/50%, high flexibility.
- UH : peak usage during any time interval.
- UL : minimum usage during any time interval.

7.4 SPPF SPECIFICATIONS

As mentioned above, the NON-SPPF portion of the entire system load will be set at 85%. This means that 15% of the system load will be made up by SPPF's as follows:

- Five small SPPF's each consuming 0.5% of the total system wide demand. These SPPF's are labeled A1 through A5.

- Five intermediate SPPF's each consuming 1% of the total system wide demand. These SPPF's are labeled B1 through B5.

- Five large SPPF's each consuming 1.5% of the total system wide demand. These SPPF's are labeled C1 through C5.

Some of these 15 SPPF's have fixed load schedules which are obtained by multiplying the original system wide load by 0.5%, 1%, or 1.5%

respectively during each time interval. The remaining SPPF's have shiftable loads where the total demand over the 24 hour period, UT, is obtained by taking 0.5%, 1%, or 1.5% of the total system wide demand over the 24 hour period. Among these SPPF's with shiftable loads, some will have the high flexibility, while other will have the low flexibilty, as discussed above.

The following detailed SPPF descriptions are provided:

- A1: Fixed load, optimum storage.

- A2: Fixed load, storage level below optimum evel.

- A3: Shiftable load, high flexibility, no storage, low independent generation.

- A4: Shiftable load, low flexibility, no storage, low independent generation.

- A5: Shiftable load, low flexibility, no storage, low independent generation, with dependent generation.

- B1: Fixed load, optimum storage.

- B2: Fixed load, storage above optimum level.

- B3: Shiftable load, low flexibility, same storage level as case B1.

- B4: Shiftable load, high flexibility, same storage level as case B1.

- B5: Shiftable load, high felxibility, same storage level as case B1.

- C1: Fixed load, optimum storage.

- C2: Shiftable load, low flexibility, optimum storage.

- C3: Shiftabel load, high flexibility, optimum storage.

- C4: Shiftable load, low flexibility, optimum storage, with dependent generation.

- C5: Shiftable load, high flexibility, optimum storage, with dependent generation.

7.5 OPTIMUM STORAGE DETERMINATIONS

The optimum storage determination for SPPF's A1, B1, C1, C2, C3, C4, and C5 are given in Tables 26 through 32.

7.6 RESULTS FROM PROGRAM TSCH

Once the actual energy storage levels to be used are obtained, using Program TSTG1, then Program TSCH can be executed.

7.6.1 Detailed Schedule Outputs for Each SPPF

The inputs for Program TSCH are very similar to those required for Program TSCH1 with the exception that for TSCH any number of SPPF's can be optimized one after the other. In this case 15 consecutive SPPF optimizations are carried out. The corresponding detailed schedule outputs are given in Tables 33 through 47.

A few comments are useful at this point:

The detailed schedule not only provides the net cost, or the net revenue, for the SPPF, but also the net revenue, or net cost, for the utility. The difference between these two numbers is the local generation costs incurred by the SPPF and which are not "seen" by the utility.

For the SPPF's for which Program TSTG1 was executed, to determine the optimum storage level, the detailed schedules provided here are identical.

7.6.2 System Wide Optimum Schedule

Program TSCH also provides a global output listing for the entire system as follows:

- Data for the NON-SPPF load. For each of the 12 time intervals the total demand from the NON-SPPF load is given. In this case this data corresponds to 85% of the actual 1990 data provided by TVA. It is of interest to remember that the total system peak for this day would have been 22000 MWh for one hour. The program also prints the revenue from the NON-SPPF load at 18855133.50 $, which means that the actual revenue for the 1990 data would have been: 22182510.00 $.

The program prints two so-called "Quality Factors":

- QF1 is ratio of the peak demand to the minimum demand.

- QF2 is the so-called demand factor which gives the ratio of the average demand to the peak demand.

- A condensed output schedule for each of the 15 SPPF's where only the demand, as seen from the utility is printed. A negative demand means that the particular SPPF actually sells energy back to the utility during the particular time interval.

  For each SPPF the net cost, or net revenue, is provided in $. Also, the net revenue, or net cost, for the utility is provided in $, this data is duplicated from the detailed schedule printouts.

- A summary is provided of the load, as seen from the utility, due to all SPPF's together along with the total revenue seen by the utility as a result of all 15 SPPF's.

- Finally, the program prints the total system demand curve, taking all 15 SPPF's into account along with the NON-SPPF load.

  The total revenue for the utility is provided.

  Finally, the two quality factors are again printed, but now taking the entire system wide load into account, including the 15 SPPF's.

The related data is given in Table 48.

7.6.3 Graphical Output

To provide for an easy reading of the results, Program TSCH also provides a plotted output of all results: for the NON-SPPF load, for each of the 15 SPPF's, for all SPPF's together, and for the entire system load. These results are shown in Figures 2 through 19.

7.7 CONCLUSIONS FOR THE SYSTEM WIDE SIMULATION

A number of very interesting conclusions can be arrived at following the system wide simulation:

- The new system wide load peak demand, including the 15 SPPF's now is 19064.57 MWh during one hour. This compares to the 22000 MWh arrived at had the 15 SPPF's been replaced by standard loads not having any degrees of freedom in their scheduling. This is a reduction of some 13.4% of the peak system demand. Actually, the peak demand of the NON-SPPF load alone is 18700 MWh, this means that during the peak hour the contribution of the SPPF's to the peak demand is almost zero. This is clearly a rather dramatic demonstration of the possible impact of SPPF's on the system demand.

- The original value of the QF1 Quality Factor, which gives the ratio of the peak demand to the lowest demand, was 1.5827, which would also havd been the value for the entire system load had no SPPF's been present. The new value, when the SPPF's are incorporated, is down to 1.2741, again reflecting the dramatic effect of the SPPF's.

- The original value of the demand factor, QF2, which is the Quality Factor relating the average demand to the peak demand, was 0.8222. The new value, when the SPPF's are incorporated, is up to 0.9011, again reflecting the dramatic effect of the SPPF's.

- The new total revenue for the utility is $ 20257021.84. This is clearly below the previous value of 22182510.00 which would have been arrived at should the SPPF's have been replaced by standard loads. However, one must keep in mind that this lower revenue could well be compensated by a significantly lower generation cost since the peak demand has been very dramatically reduced. Indeed, peak generation costs are the most expensive ones from a marginal cost point of view. The only way to actually get a global response to the revenue issue would be to integrate this procedure with a so-called corporate model.

- When analysing these results it is important to remember that the total demand over the 24 hour period is not changed when the 15 SPPF's are integrated, since this was the way the SPPF's were originally specified.

TABLE 26.

OPTIMUM STORAGE CAPACITY DETERMINATION: SPPF A1

IOPT= 1 DT= 2.00 N= 12 NAME = A1
R1= 50.00 R2= 50.00 ALFA= 0.00000 EPS= .820 DEL= .820
GAMMA= .980 MEU= .960

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	21.3750	26.1250	31.9000	200.00	148.50
2	21.4200	26.1800	31.9000	200.00	139.00
3	21.3300	26.0700	31.9000	200.00	140.00
4	21.4200	26.1800	31.9000	200.00	157.50
5	22.5450	27.5550	31.9000	200.00	174.50
6	32.1500	39.2700	31.9000	200.00	191.50
7	48.4650	55.3850	31.9000	200.00	206.50
8	68.7150	83.9850	31.9000	200.00	218.00
9	72.2700	88.3300	31.9000	200.00	211.00
10	57.0150	74.6850	31.9000	200.00	213.00
11	33.6150	41.0850	31.9000	200.00	193.50
12	21.8250	26.6750	31.9000	200.00	168.50

XO= 0.00 REVENUE= -61817.92 ERROR= 0

PERIOD \ K	1	2	3	4	5	6	7
1	0.00	0.00	0.00	0.00	151.53	0.00	0.00
2	121.95	0.00	0.00	0.00	141.84	0.00	0.00
3	121.95	0.00	0.00	0.00	142.86	0.00	0.00
4	121.95	0.00	0.00	0.00	160.71	0.00	0.00
5	121.95	0.00	0.00	0.00	178.06	0.00	0.00
6	0.00	0.00	0.00	191.50	0.00	0.00	0.00
7	0.00	0.00	0.00	200.00	0.00	6.50	11.05
8	0.00	0.00	0.00	200.00	0.00	18.00	64.00
9	0.00	0.00	0.00	200.00	0.00	11.00	71.00
10	0.00	0.00	0.00	200.00	0.00	13.00	69.00
11	0.00	0.00	6.37	193.50	0.00	0.00	0.00
12	.00	0.00	0.00	0.00	171.94	0.00	0.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= 0.00

OPTIMUM STORAGE CAPACITY= 376.63

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LEVEL	LOSS	PROFIT
1	0.00	0.00	148.50	0.00	151.53	0.00	0.00	3.03	-3958.74
2	0.00	0.00	139.00	0.00	263.79	100.00	100.00	24.79	-6905.97
3	0.00	0.00	140.00	0.00	264.81	100.00	196.00	24.81	-6903.55
4	0.00	0.00	157.50	0.00	282.67	100.00	288.16	25.17	-7400.18
5	0.00	0.00	174.50	0.00	300.01	100.00	376.63	25.51	-8266.84
6	191.50	0.00	191.50	0.00	0.00	0.00	361.57	0.00	-6108.85
7	200.00	0.00	206.50	11.05	0.00	-21.40	325.70	3.85	-5844.41
8	200.00	0.00	218.00	64.00	0.00	-100.00	212.67	18.00	-1982.24
9	200.00	0.00	211.00	71.00	0.00	-100.00	104.17	18.00	-1248.83
10	200.00	0.00	213.00	69.00	0.00	-100.00	.00	18.00	-2445.97
11	200.00	0.00	193.50	6.37	0.00	0.00	.00	.13	-6165.87
12	0.00	0.00	168.50	0.00	171.94	.00	.00	3.44	-4586.47

TOTAL COST FOR SPPF= 61817.92

TABLE 27.

OPTIMUM STORAGE CAPACITY DETERMINATION: SPPF B1

IOPT= 1 DT= 2.00 N= 12 NAME = B1
R1= 50.00 R2= 50.00 ALFA= 0.00000 EPS= .820 DEL= .820
GAMMA= .980 MEU= .960

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	21.3750	26.1250	31.9000	200.00	297.00
2	21.4200	26.1800	31.9000	200.00	278.00
3	21.3300	26.0700	31.9000	200.00	280.00
4	21.4200	26.1800	31.9000	200.00	315.00
5	22.5450	27.5550	31.9000	200.00	349.00
6	32.1500	39.2700	31.9000	200.00	383.00
7	48.4650	55.3850	31.9000	200.00	413.00
8	68.7150	83.9850	31.9000	200.00	436.00
9	72.2700	88.3300	31.9000	200.00	440.00
10	57.0150	74.6850	31.9000	200.00	426.00
11	33.6150	41.0850	31.9000	200.00	387.00
12	21.8250	26.6750	31.9000	200.00	337.00

XO= .41 REVENUE=-165586.78 ERROR= 0

K PERIOD	1	2	3	4	5	6	7
1	121.95	0.00	0.00	0.00	303.06	0.00	0.00
2	121.95	0.00	0.00	0.00	283.67	0.00	0.00
3	121.95	0.00	0.00	0.00	285.71	0.00	0.00
4	121.95	0.00	0.00	0.00	321.43	0.00	0.00
5	121.95	0.00	0.00	0.00	356.12	0.00	0.00
6	0.00	0.00	0.00	200.00	186.73	0.00	0.00
7	0.00	0.00	0.00	200.00	133.67	82.00	0.00
8	0.00	0.00	0.00	200.00	157.14	82.00	0.00
9	0.00	0.00	0.00	200.00	161.22	82.00	0.00
10	0.00	0.00	0.00	200.00	146.94	82.00	0.00
11	0.00	0.00	0.00	200.00	190.82	.00	0.00
12	.50	0.00	0.00	0.00	343.88	0.00	0.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= .41

OPTIMUM STORAGE CAPACITY= 461.92

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LEVEL	LOSS	PROFIT
1	0.00	0.00	297.00	0.00	425.01	100.00	100.39	28.01	-11103.45
2	0.00	0.00	278.00	0.00	405.62	100.00	196.38	27.62	-10619.25
3	0.00	0.00	280.00	0.00	407.67	100.00	288.52	27.67	-10627.84
4	0.00	0.00	315.00	0.00	443.38	100.00	376.98	28.38	-11607.68
5	0.00	0.00	349.00	0.00	478.07	100.00	461.90	29.07	-13173.32
6	200.00	0.00	383.00	0.00	186.73	0.00	443.43	3.73	-13713.07
7	200.00	0.00	413.00	0.00	133.67	-100.00	325.69	20.67	-13783.51
8	200.00	0.00	436.00	0.00	157.14	-100.00	212.66	21.14	-19577.64
9	200.00	0.00	440.00	0.00	161.22	-100.00	104.15	21.22	-20620.96
10	200.00	0.00	426.00	0.00	146.94	-100.00	-.01	20.94	-17354.12
11	200.00	0.00	387.00	0.00	190.82	-.00	-.01	3.82	-14219.69
12	0.00	0.00	337.00	0.00	344.38	.41	.40	6.97	-9186.25

TOTAL COST FOR SPPF= 165586.78

TABLE 28.

OPTIMUM STORAGE CAPACITY DETERMINATION: SPPF C1

IOPT= 1 DT= 2.00 N= 12 NAME = C1
R1= 50.00 R2= 50.00 ALFA= 0.00000 EPS= .820 DEL= .820
GAMMA= .980 MEU= .960

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	21.3750	26.1250	31.9000	200.00	445.50
2	21.4200	26.1800	31.9000	200.00	417.00
3	21.3300	26.0700	31.9000	200.00	420.00
4	21.4200	26.1800	31.9000	200.00	472.50
5	22.5450	27.5550	31.9000	200.00	523.50
6	32.1500	39.2700	31.9000	200.00	574.50
7	48.4650	55.3850	31.9000	200.00	619.50
8	68.7150	83.9850	31.9000	200.00	654.00
9	72.2700	88.3300	31.9000	200.00	660.00
10	57.0150	74.6850	31.9000	200.00	639.00
11	33.6150	41.0850	31.9000	200.00	580.50
12	21.8250	26.6750	31.9000	200.00	505.50

XO= .41 REVENUE=-272883.94 ERROR= 0

K / PERIOD	1	2	3	4	5	6	7
1	121.95	0.00	0.00	0.00	454.59	0.00	0.00
2	121.95	0.00	0.00	0.00	425.51	0.00	0.00
3	121.95	0.00	0.00	0.00	428.57	0.00	0.00
4	121.95	0.00	0.00	0.00	482.14	0.00	0.00
5	121.95	0.00	0.00	0.00	534.18	0.00	0.00
6	0.00	0.00	0.00	200.00	382.14	0.00	0.00
7	0.00	0.00	0.00	200.00	344.39	82.00	0.00
8	0.00	0.00	0.00	200.00	379.59	82.00	0.00
9	0.00	0.00	0.00	200.00	385.71	82.00	0.00
10	0.00	0.00	0.00	200.00	364.29	82.00	0.00
11	0.00	0.00	0.00	200.00	388.27	.00	0.00
12	.50	0.00	0.00	0.00	515.82	0.00	0.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= .41

OPTIMUM STORAGE CAPACITY= 461.92

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LEVEL	LOSS	PROFIT
1	0.00	0.00	445.50	0.00	576.54	100.00	100.39	31.04	-15062.19
2	0.00	0.00	417.00	0.00	547.46	100.00	196.38	30.46	-14332.54
3	0.00	0.00	420.00	0.00	550.52	100.00	288.52	30.52	-14352.13
4	0.00	0.00	472.50	0.00	604.09	100.00	376.98	31.59	-15815.18
5	0.00	0.00	523.50	0.00	656.13	100.00	461.90	32.63	-18079.80
6	200.00	0.00	574.50	0.00	382.14	0.00	443.43	7.64	-21386.75
7	200.00	0.00	619.50	0.00	344.39	-100.00	325.69	24.89	-25453.92
8	200.00	0.00	654.00	0.00	379.59	-100.00	212.66	25.59	-38260.02
9	200.00	0.00	660.00	0.00	385.71	-100.00	104.15	25.71	-40450.14
10	200.00	0.00	639.00	0.00	364.29	-100.00	-.01	25.29	-33586.68
11	200.00	0.00	580.50	0.00	388.27	-.00	-.01	7.77	-22331.88
12	0.00	0.00	505.50	0.00	516.32	.41	.40	10.41	-13772.71

TOTAL COST FOR SPPF= 272883.94

TABLE 29.

OPTIMUM STORAGE CAPACITY DETERMINATION: SPPF C2

ICPT= 3 DT= 2.00 N= 12 NAME = C2
R1= 50.00 R2= 50.00 ALFA= 0.00000 EPS= .820 DEL= .820
GAMMA= .980 MEU= .960
UT= 6511.50 UL= 540.00 UH= 720.00

K	P(K)	Q(K)	R(K)	G(K)
1	21.3750	26.1250	31.9000	200.00
2	21.4200	26.1800	31.9000	200.00
3	21.3300	26.0700	31.9000	200.00
4	21.4200	26.1800	31.9000	200.00
5	22.5450	27.5550	31.9000	200.00
6	32.1500	39.2700	31.9000	200.00
7	48.4650	55.3850	31.9000	200.00
8	68.7150	83.9850	31.9000	200.00
9	72.2700	88.3300	31.9000	200.00
10	57.0150	74.6850	31.9000	200.00
11	33.6150	41.0850	31.9000	200.00
12	21.8250	26.6750	31.9000	200.00

XO= 0.00 REVENUE=-250223.31 ERROR= 0

K / PERIOD	1	2	3	4	5	6	7	8
1	121.95	0.00	0.00	0.00	551.02	0.00	0.00	540.00
2	121.95	0.00	0.00	0.00	551.02	0.00	0.00	540.00
3	121.95	0.00	0.00	0.00	583.16	0.00	0.00	571.50
4	121.95	0.00	0.00	0.00	551.02	0.00	0.00	540.00
5	121.95	0.00	0.00	0.00	551.02	0.00	0.00	540.00
6	0.00	0.00	0.00	200.00	346.94	0.00	0.00	540.00
7	0.00	0.00	0.00	200.00	263.53	81.74	0.00	540.00
8	0.00	0.00	0.00	200.00	263.27	82.00	0.00	540.00
9	0.00	0.00	0.00	200.00	263.27	82.00	0.00	540.00
10	0.00	0.00	0.00	200.00	263.27	82.00	0.00	540.00
11	0.00	0.00	0.00	200.00	346.94	.00	0.00	540.00
12	.00	0.00	0.00	0.00	551.02	0.00	0.00	540.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= 0.00

OPTIMUM STORAGE CAPACITY= 461.57

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LEVEL	LOSS	PROFIT
1	0.00	0.00	540.00	0.00	672.97	100.00	100.00	32.97	-17581.38
2	0.00	0.00	540.00	0.00	672.97	100.00	196.00	32.97	-17618.40
3	0.00	0.00	571.50	0.00	705.11	100.00	288.16	33.61	-18382.33
4	0.00	0.00	540.00	0.00	672.97	100.00	376.63	32.97	-17618.40
5	0.00	0.00	540.00	0.00	672.97	100.00	461.57	32.97	-18543.73
6	200.00	0.00	540.00	0.00	346.94	0.00	443.11	6.94	-20004.29
7	200.00	0.00	540.00	0.00	263.53	-99.68	325.70	23.21	-20975.80
8	200.00	0.00	540.00	0.00	263.27	-100.00	212.67	23.27	-28490.34
9	200.00	0.00	540.00	0.00	263.27	-100.00	104.17	23.27	-29634.22
10	200.00	0.00	540.00	0.00	263.27	-100.00	-.00	23.27	-26041.97
11	200.00	0.00	540.00	0.00	346.94	-.00	-.00	6.94	-20633.98
12	0.00	0.00	540.00	0.00	551.02	.00	-.00	11.02	-14698.47

TOTAL COST FOR SPPF= 250223.31

TABLE 30.

OPTIMUM STORAGE CAPACITY DETERMINATION: SPPF C3

IOPT= 3 DT= 2.00 N= 12 NAME = C3
R1= 50.00 R2= 50.00 ALFA= 0.00000 EPS= .820 DEL= .820
GAMMA= .980 MEU= .960
UT= 6511.50 UL= 360.00 UH= 720.00

K	P(K)	Q(K)	R(K)	G(K)
1	21.3750	26.1250	31.9000	200.00
2	21.4200	26.1800	31.9000	200.00
3	21.3300	26.0700	31.9000	200.00
4	21.4200	26.1800	31.9000	200.00
5	22.5450	27.5550	31.9000	200.00
6	32.1500	39.2700	31.9000	200.00
7	48.4650	55.3850	31.9000	200.00
8	68.7150	83.9850	31.9000	200.00
9	72.2700	88.3300	31.9000	200.00
10	57.0150	74.6850	31.9000	200.00
11	33.6150	41.0850	31.9000	200.00
12	21.8250	26.6750	31.9000	200.00

XO= 0.00 REVENUE=-209513.00 ERROR= 0

PERIOD \ K	1	2	3	4	5	6	7	8
1	121.95	0.00	0.00	0.00	734.69	0.00	0.00	720.00
2	121.95	0.00	0.00	0.00	734.69	0.00	0.00	720.00
3	121.95	0.00	0.00	0.00	734.69	0.00	0.00	720.00
4	121.95	0.00	0.00	0.00	734.69	0.00	0.00	720.00
5	121.95	0.00	0.00	0.00	734.69	0.00	0.00	720.00
6	0.00	0.00	0.00	200.00	195.41	0.00	0.00	391.50
7	0.00	0.00	0.00	200.00	79.86	81.74	0.00	360.00
8	0.00	0.00	0.00	200.00	79.59	82.00	0.00	360.00
9	0.00	0.00	0.00	200.00	79.59	82.00	0.00	360.00
10	0.00	0.00	0.00	200.00	79.59	82.00	0.00	360.00
11	0.00	0.00	0.00	200.00	163.27	.00	0.00	360.00
12	.00	0.00	0.00	0.00	734.69	0.00	0.00	720.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= 0.00

OPTIMUM STORAGE CAPACITY= 461.57

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LEVEL	LOSS	PROFIT
1	0.00	0.00	720.00	0.00	856.65	100.00	100.00	36.65	-22379.85
2	0.00	0.00	720.00	0.00	856.65	100.00	196.00	36.65	-22426.97
3	0.00	0.00	720.00	0.00	856.65	100.00	288.16	36.65	-22332.74
4	0.00	0.00	720.00	0.00	856.65	100.00	376.63	36.65	-22426.97
5	0.00	0.00	720.00	0.00	856.65	100.00	461.57	36.65	-23604.86
6	200.00	0.00	391.50	0.00	195.41	0.00	443.11	3.91	-14053.68
7	200.00	0.00	360.00	0.00	79.86	-99.68	325.70	19.54	-10803.04
8	200.00	0.00	360.00	0.00	79.59	-100.00	212.67	19.59	-13064.52
9	200.00	0.00	360.00	0.00	79.59	-100.00	104.17	19.59	-13410.35
10	200.00	0.00	360.00	0.00	79.59	-100.00	-.00	19.59	-12324.32
11	200.00	0.00	360.00	0.00	163.27	-.00	-.00	3.27	-13087.76
12	0.00	0.00	720.00	0.00	734.69	.00	-.00	14.69	-19597.96

TOTAL COST FOR SPPF= 209513.00

TABLE 31.

OPTIMUM STORAGE CAPACITY DETERMINATION: SPPF C4

IOPT= 5 DT= 2.00 N= 12 NAME = C4
R1= 50.00 R2= 50.00 ALFA= 0.00000 EPS= .820 DEL= .820
BETA= .500 GAMMA= .980 MEU= .960
UT= 6511.50 UL= 540.00 UH= 720.00

K	P(K)	Q(K)	R(K)	G(K)
1	21.3750	26.1250	31.9000	200.00
2	21.4200	26.1800	31.9000	200.00
3	21.3300	26.0700	31.9000	200.00
4	21.4200	26.1800	31.9000	200.00
5	22.5450	27.5550	31.9000	200.00
6	32.1500	39.2700	31.9000	200.00
7	48.4650	55.3850	31.9000	200.00
8	68.7150	83.9850	31.9000	200.00
9	72.2700	88.3300	31.9000	200.00
10	57.0150	74.6850	31.9000	200.00
11	33.6150	41.0850	31.9000	200.00
12	21.8250	26.6750	31.9000	200.00

XO= 0.00 REVENUE=-129707.58 ERROR= 0

K PERIOD	1	2	3	4	5	6	7	8	9	10
1	0.00	0.00	0.00	0.00	551.02	0.00	0.00	540.00	121.95	145.09
2	0.00	0.00	0.00	0.00	551.02	0.00	0.00	540.00	121.95	145.09
3	0.00	0.00	0.00	0.00	583.16	0.00	0.00	571.50	121.95	160.52
4	0.00	0.00	0.00	0.00	551.02	0.00	0.00	540.00	121.95	145.09
5	0.00	0.00	0.00	0.00	551.02	0.00	0.00	540.00	121.95	145.09
6	0.00	0.00	0.00	200.00	346.94	0.00	0.00	540.00	.41	264.20
7	0.00	0.00	0.00	200.00	263.27	82.00	0.00	540.00	0.00	264.60
8	0.00	0.00	0.00	200.00	263.27	82.00	0.00	540.00	0.00	264.60
9	0.00	0.00	0.00	200.00	263.27	82.00	0.00	540.00	0.00	264.60
10	0.00	0.00	0.00	200.00	263.27	82.00	0.00	540.00	0.00	264.60
11	0.00	0.00	0.00	200.00	346.94	-.00	0.00	540.00	0.00	264.60
12	0.00	0.00	0.00	0.00	551.02	.00	0.00	540.00	0.00	264.60

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= 0.00

OPTIMUM STORAGE CAPACITY= 461.57

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LEVEL	LOSS	PROFIT
1	0.00	270.00	540.00	145.09	551.02	100.00	100.00	32.97	-11294.16
2	0.00	270.00	540.00	145.09	551.02	100.00	196.00	32.97	-11317.93
3	0.00	285.75	571.50	160.52	583.16	100.00	288.16	33.61	-11779.11
4	0.00	270.00	540.00	145.09	551.02	100.00	376.63	32.97	-11317.93
5	0.00	270.00	540.00	145.09	551.02	100.00	461.57	32.97	-11912.36
6	200.00	270.00	540.00	264.20	346.94	.33	443.44	7.01	-11510.22
7	200.00	270.00	540.00	264.60	263.27	-100.00	325.70	23.27	-8137.11
8	200.00	270.00	540.00	264.60	263.27	-100.00	212.67	23.27	-10308.35
9	200.00	270.00	540.00	264.60	263.27	-100.00	104.17	23.27	-10511.58
10	200.00	270.00	540.00	264.60	263.27	-100.00	-.00	23.27	-10955.80
11	200.00	270.00	540.00	264.60	346.94	.00	-.00	6.94	-11739.45
12	0.00	270.00	540.00	264.60	551.02	-.00	-.00	11.02	-8923.57

TOTAL COST FOR SPPF= 129707.58

TABLE 32.

OPTIMUM STORAGE CAPACITY DETERMINATION: SPPF C5

IOPT= 5 DT= 2.00 N= 12 NAME = C5
R1= 50.00 R2= 50.00 ALFA= 0.00000 EPS= .820 DEL= .820
BETA= .500 GAMMA= .980 MEU= .960
UT= 6511.50 UL= 360.00 UH= 720.00

K	P(K)	Q(K)	R(K)	G(K)
1	21.3750	26.1250	31.9000	200.00
2	21.4200	26.1800	31.9000	200.00
3	21.3300	26.0700	31.9000	200.00
4	21.4200	26.1800	31.9000	200.00
5	22.5450	27.5550	31.9000	200.00
6	32.1500	39.2700	31.9000	200.00
7	48.4650	55.3850	31.9000	200.00
8	68.7150	83.9850	31.9000	200.00
9	72.2700	88.3300	31.9000	200.00
10	57.0150	74.6850	31.9000	200.00
11	33.6150	41.0850	31.9000	200.00
12	21.8250	26.6750	31.9000	200.00

XO= 0.00 REVENUE=-104910.46 ERROR= 0

K / PERIOD	1	2	3	4	5	6	7	8	9	10
1	0.00	0.00	0.00	0.00	734.69	0.00	0.00	720.00	121.95	233.29
2	0.00	0.00	0.00	0.00	734.69	0.00	0.00	720.00	121.95	233.29
3	0.00	0.00	0.00	0.00	734.69	0.00	0.00	720.00	121.95	233.29
4	0.00	0.00	0.00	0.00	734.69	0.00	0.00	720.00	121.95	233.29
5	0.00	0.00	0.00	0.00	734.69	0.00	0.00	720.00	121.95	233.29
6	0.00	0.00	0.00	200.00	195.41	0.00	0.00	391.50	.41	191.44
7	0.00	0.00	0.00	200.00	79.59	82.00	0.00	360.00	0.00	176.40
8	0.00	0.00	0.00	200.00	79.59	82.00	0.00	360.00	0.00	176.40
9	0.00	0.00	0.00	200.00	79.59	82.00	0.00	360.00	0.00	176.40
10	0.00	0.00	0.00	200.00	79.59	82.00	0.00	360.00	0.00	176.40
11	0.00	0.00	0.00	200.00	163.27	-.00	0.00	360.00	0.00	176.40
12	0.00	0.00	0.00	0.00	734.69	.00	0.00	720.00	0.00	352.80

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= 0.00

OPTIMUM STORAGE CAPACITY= 461.57

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LEVEL	LOSS	PROFIT
1	0.00	360.00	720.00	233.29	734.69	100.00	100.00	36.65	-14207.35
2	0.00	360.00	720.00	233.29	734.69	100.00	196.00	36.65	-14237.26
3	0.00	360.00	720.00	233.29	734.69	100.00	288.16	36.65	-14177.44
4	0.00	360.00	720.00	233.29	734.69	100.00	376.63	36.65	-14237.26
5	0.00	360.00	720.00	233.29	734.69	100.00	461.57	36.65	-14985.02
6	200.00	195.75	391.50	191.44	195.41	.33	443.44	3.98	-7899.01
7	200.00	180.00	360.00	176.40	79.59	-100.00	325.70	19.59	-2238.97
8	200.00	180.00	360.00	176.40	79.59	-100.00	212.67	19.59	-943.19
9	200.00	180.00	360.00	176.40	79.59	-100.00	104.17	19.59	-661.92
10	200.00	180.00	360.00	176.40	79.59	-100.00	.00	19.59	-2266.87
11	200.00	180.00	360.00	176.40	163.27	.00	.00	3.27	-7158.07
12	0.00	360.00	720.00	352.80	734.69	-.00	-.00	14.69	-11898.10

TOTAL COST FOR SPPF= 104910.46

TABLE 33.

OPTIMUM SCHEDULE: SPPF A1

IOPT= 1 DT= 2.00 N= 12 NAME = A1
R1= 50.00 R2= 50.00 S= 376.63 EPS= .820 DEL= .820
GAMMA= .980 MEU= .960

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	21.3750	26.1250	31.9000	200.00	148.50
2	21.4200	26.1800	31.9000	200.00	139.00
3	21.3300	26.0700	31.9000	200.00	140.00
4	21.4200	26.1800	31.9000	200.00	157.50
5	22.5450	27.5550	31.9000	200.00	174.50
6	32.1500	39.2700	31.9000	200.00	191.50
7	48.4650	55.3850	31.9000	200.00	206.50
8	68.7150	83.9850	31.9000	200.00	218.00
9	72.2700	88.3300	31.9000	200.00	211.00
10	57.0150	74.6850	31.9000	200.00	213.00
11	33.6150	41.0850	31.9000	200.00	193.50
12	21.8250	26.6750	31.9000	200.00	168.50

XO= 0.00 REVENUE= -61817.92 ERROR= 0

K PERIOD	1	2	3	4	5	6	7
1	0.00	0.00	0.00	0.00	151.53	0.00	0.00
2	121.95	0.00	0.00	0.00	141.84	0.00	0.00
3	121.95	0.00	0.00	0.00	142.86	0.00	0.00
4	121.95	0.00	0.00	0.00	160.71	0.00	0.00
5	121.95	0.00	0.00	0.00	178.06	0.00	0.00
6	0.00	0.00	0.00	191.50	0.00	0.00	0.00
7	0.00	0.00	0.00	200.00	0.00	6.50	11.05
8	0.00	0.00	0.00	200.00	0.00	18.00	64.00
9	0.00	0.00	0.00	200.00	0.00	11.00	71.00
10	0.00	0.00	0.00	200.00	0.00	13.00	69.00
11	0.00	0.00	6.37	193.50	0.00	0.00	0.00
12	.00	0.00	0.00	0.00	171.94	0.00	0.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= 0.00

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LEVEL	LOSS	PROFIT
1	0.00	0.00	148.50	0.00	151.53	0.00	0.00	3.03	-3958.74
2	0.00	0.00	139.00	0.00	263.78	100.00	100.00	24.79	-6905.84
3	0.00	0.00	140.00	0.00	264.81	100.00	196.00	24.81	-6903.55
4	0.00	0.00	157.50	0.00	282.67	100.00	288.16	25.17	-7400.18
5	0.00	0.00	174.50	0.00	300.01	100.00	376.63	25.51	-8266.84
6	191.50	0.00	191.50	0.00	0.00	0.00	361.56	0.00	-6108.85
7	200.00	0.00	206.50	11.05	0.00	-21.40	325.70	3.85	-5844.54
8	200.00	0.00	218.00	64.00	0.00	-100.00	212.67	18.00	-1982.24
9	200.00	0.00	211.00	71.00	0.00	-100.00	104.17	18.00	-1248.83
10	200.00	0.00	213.00	69.00	0.00	-100.00	.00	18.00	-2445.97
11	200.00	0.00	193.50	6.37	0.00	0.00	.00	.13	-6165.87
12	0.00	0.00	168.50	0.00	171.94	.00	.00	3.44	-4586.47

NET COST FOR SPPF = 61817.92
NET REVENUE FOR UTILITY = 23809.07

TABLE 34.

OPTIMUM SCHEDULE: SPPF A2

IOPT= 1 DT= 2.00 N= 12 NAME = A2
R1= 50.00 R2= 50.00 S= 100.00 EPS= .820 DEL= .820
GAMMA= .980 MEU= .960

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	21.3750	26.1250	31.9000	200.00	148.50
2	21.4200	26.1800	31.9000	200.00	139.00
3	21.3300	26.0700	31.9000	200.00	140.00
4	21.4200	26.1800	31.9000	200.00	157.50
5	22.5450	27.5550	31.9000	200.00	174.50
6	32.1500	39.2700	31.9000	200.00	191.50
7	48.4650	55.3850	31.9000	200.00	206.50
8	68.7150	83.9850	31.9000	200.00	218.00
9	72.2700	88.3300	31.9000	200.00	211.00
10	57.0150	74.6850	31.9000	200.00	213.00
11	33.6150	41.0850	31.9000	200.00	193.50
12	21.8250	26.6750	31.9000	200.00	168.50

XO= 0.00 REVENUE= -64520.91 ERROR= 0

K PERIOD	1	2	3	4	5	6	7
1	0.00	0.00	0.00	0.00	151.53	0.00	0.00
2	0.00	0.00	0.00	0.00	141.84	0.00	0.00
3	0.00	0.00	0.00	0.00	142.86	0.00	0.00
4	121.95	0.00	0.00	0.00	160.71	0.00	0.00
5	4.88	0.00	0.00	0.00	178.06	0.00	0.00
6	0.00	4.88	0.00	191.50	0.00	0.00	0.00
7	0.00	0.00	0.00	200.00	6.63	0.00	0.00
8	0.00	0.00	0.00	200.00	0.00	18.00	0.00
9	0.00	0.00	0.00	200.00	0.00	11.00	30.73
10	0.00	0.00	0.00	200.00	0.00	13.00	0.00
11	0.00	0.00	6.37	193.50	0.00	0.00	0.00
12	-.00	0.00	0.00	0.00	171.94	0.00	0.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= 0.00

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LEVEL	LOSS	PROFIT
1	0.00	0.00	148.50	0.00	151.53	0.00	0.00	3.03	-3958.74
2	0.00	0.00	139.00	0.00	141.84	0.00	0.00	2.84	-3713.29
3	0.00	0.00	140.00	0.00	142.86	0.00	0.00	2.86	-3724.29
4	0.00	0.00	157.50	0.00	282.67	100.00	100.00	25.17	-7400.18
5	0.00	0.00	174.50	0.00	182.94	4.00	100.00	4.44	-5040.89
6	196.38	0.00	191.50	0.00	0.00	4.00	100.00	.88	-6264.46
7	200.00	0.00	206.50	0.00	6.63	0.00	96.00	.13	-6747.35
8	200.00	0.00	218.00	0.00	0.00	-21.95	70.21	3.95	-6380.00
9	200.00	0.00	211.00	30.73	0.00	-50.89	16.51	9.16	-4159.38
10	200.00	0.00	213.00	0.00	0.00	-15.85	.00	2.85	-6380.00
11	200.00	0.00	193.50	6.37	0.00	0.00	.00	.13	-6165.87
12	0.00	0.00	168.50	0.00	171.94	-.00	.00	3.44	-4586.47

NET COST FOR SPPF = 64520.91
NET REVENUE FOR UTILITY = 26356.45

TABLE 35.

OPTIMUM SCHEDULE: SPPF A3

IDPT= 3 DT= 2.00 N= 12 NAME = A3
R1= 50.00 R2= 50.00 S= 0.00 EPS= .820 DEL= .820
GAMMA= .980 MEU= .960
UT= 2170.50 UL= 120.00 UH= 240.00

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	21.3750	26.1250	31.9000	100.00	148.50
2	21.4200	26.1800	31.9000	100.00	139.00
3	21.3300	26.0700	31.9000	100.00	140.00
4	21.4200	26.1800	31.9000	100.00	157.50
5	22.5450	27.5550	31.9000	100.00	174.50
6	32.1500	39.2700	31.9000	100.00	191.50
7	48.4650	55.3850	31.9000	100.00	206.50
8	68.7150	83.9850	31.9000	100.00	218.00
9	72.2700	88.3300	31.9000	100.00	211.00
10	57.0150	74.6850	31.9000	100.00	213.00
11	33.6150	41.0850	31.9000	100.00	193.50
12	21.8250	26.6750	31.9000	100.00	168.50

XO= 0.00 REVENUE= -66257.89 ERROR= 0

K PERIOD	1	2	3	4	5	6	7	8
1	0.00	0.00	0.00	0.00	244.90	0.00	0.00	240.00
2	0.00	0.00	0.00	0.00	244.90	0.00	0.00	240.00
3	0.00	0.00	0.00	0.00	244.90	0.00	0.00	240.00
4	0.00	0.00	0.00	0.00	244.90	0.00	0.00	240.00
5	0.00	0.00	0.00	0.00	244.90	0.00	0.00	240.00
6	0.00	0.00	0.00	100.00	31.12	0.00	0.00	130.50
7	0.00	0.00	0.00	100.00	20.41	0.00	0.00	120.00
8	0.00	0.00	0.00	100.00	20.41	0.00	0.00	120.00
9	0.00	0.00	0.00	100.00	20.41	0.00	0.00	120.00
10	0.00	0.00	0.00	100.00	20.41	0.00	0.00	120.00
11	0.00	0.00	0.00	100.00	20.41	0.00	0.00	120.00
12	0.00	0.00	0.00	0.00	244.90	0.00	0.00	240.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= 0.00

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LEVEL	LOSS	PROFIT
1	0.00	0.00	240.00	0.00	244.90	0.00	0.00	4.90	-6397.96
2	0.00	0.00	240.00	0.00	244.90	0.00	0.00	4.90	-6411.43
3	0.00	0.00	240.00	0.00	244.90	0.00	0.00	4.90	-6384.49
4	0.00	0.00	240.00	0.00	244.90	0.00	0.00	4.90	-6411.43
5	0.00	0.00	240.00	0.00	244.90	0.00	0.00	4.90	-6748.16
6	100.00	0.00	130.50	0.00	31.12	0.00	0.00	.62	-4412.18
7	100.00	0.00	120.00	0.00	20.41	0.00	0.00	.41	-4320.31
8	100.00	0.00	120.00	0.00	20.41	0.00	0.00	.41	-4903.98
9	100.00	0.00	120.00	0.00	20.41	0.00	0.00	.41	-4992.65
10	100.00	0.00	120.00	0.00	20.41	0.00	0.00	.41	-4714.18
11	100.00	0.00	120.00	0.00	20.41	0.00	0.00	.41	-4028.47
12	0.00	0.00	240.00	0.00	244.90	0.00	0.00	4.90	-6532.65

NET COST FOR SPPF = 66257.89
NET REVENUE FOR UTILITY = 47117.89

TABLE 36.

OPTIMUM SCHEDULE: SPPF A4

IOPT= 3 DT= 2.00 N= 12 NAME = A4
R1= 50.00 R2= 50.00 S= 0.00 EPS= .820 DEL= .820
GAMMA= .980 MEU= .960
UT= 2170.50 UL= 180.00 UH= 240.00

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	21.3750	26.1250	31.9000	100.00	148.50
2	21.4200	26.1800	31.9000	100.00	139.00
3	21.3300	26.0700	31.9000	100.00	140.00
4	21.4200	26.1800	31.9000	100.00	157.50
5	22.5450	27.5550	31.9000	100.00	174.50
6	32.1500	39.2700	31.9000	100.00	191.50
7	48.4650	55.3850	31.9000	100.00	206.50
8	68.7150	83.9850	31.9000	100.00	218.00
9	72.2700	88.3300	31.9000	100.00	211.00
10	57.0150	74.6850	31.9000	100.00	213.00
11	33.6150	41.0850	31.9000	100.00	193.50
12	21.8250	26.6750	31.9000	100.00	168.50

XO= 0.00 REVENUE= -79827.99 ERROR= 0

PERIOD \ K	1	2	3	4	5	6	7	8
1	0.00	0.00	0.00	0.00	183.67	0.00	0.00	180.00
2	0.00	0.00	0.00	0.00	183.67	0.00	0.00	180.00
3	0.00	0.00	0.00	0.00	194.39	0.00	0.00	190.50
4	0.00	0.00	0.00	0.00	183.67	0.00	0.00	180.00
5	0.00	0.00	0.00	0.00	183.67	0.00	0.00	180.00
6	0.00	0.00	0.00	100.00	81.63	0.00	0.00	180.00
7	0.00	0.00	0.00	100.00	81.63	0.00	0.00	180.00
8	0.00	0.00	0.00	100.00	81.63	0.00	0.00	180.00
9	0.00	0.00	0.00	100.00	81.63	0.00	0.00	180.00
10	0.00	0.00	0.00	100.00	81.63	0.00	0.00	180.00
11	0.00	0.00	0.00	100.00	81.63	0.00	0.00	180.00
12	0.00	0.00	0.00	0.00	183.67	0.00	0.00	180.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= 0.00

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LEVEL	LOSS	PROFIT
1	0.00	0.00	180.00	0.00	183.67	0.00	0.00	3.67	-4798.47
2	0.00	0.00	180.00	0.00	183.67	0.00	0.00	3.67	-4808.57
3	0.00	0.00	190.50	0.00	194.39	0.00	0.00	3.89	-5067.69
4	0.00	0.00	180.00	0.00	183.67	0.00	0.00	3.67	-4808.57
5	0.00	0.00	180.00	0.00	183.67	0.00	0.00	3.67	-5061.12
6	100.00	0.00	180.00	0.00	81.63	0.00	0.00	1.63	-6395.71
7	100.00	0.00	180.00	0.00	81.63	0.00	0.00	1.63	-7711.22
8	100.00	0.00	180.00	0.00	81.63	0.00	0.00	1.63	-10045.92
9	100.00	0.00	180.00	0.00	81.63	0.00	0.00	1.63	-10400.61
10	100.00	0.00	180.00	0.00	81.63	0.00	0.00	1.63	-9286.73
11	100.00	0.00	180.00	0.00	81.63	0.00	0.00	1.63	-6543.88
12	0.00	0.00	180.00	0.00	183.67	0.00	0.00	3.67	-4899.49

NET COST FOR SPPF = 79827.99
NET REVENUE FOR UTILITY = 60687.99

TABLE 37.

OPTIMUM SCHEDULE: SPPF A5

IOPT= 5 DT= 2.00 N= 12 NAME = A5
R1= 50.00 R2= 50.00 S= 0.00 EPS= .820 DEL= .820
BETA= .500 GAMMA= .980 MEU= .960
UT= 2170.50 UL= 180.00 UH= 240.00

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	21.3750	26.1250	31.9000	100.00	148.50
2	21.4200	26.1800	31.9000	100.00	139.00
3	21.3300	26.0700	31.9000	100.00	140.00
4	21.4200	26.1800	31.9000	100.00	157.50
5	22.5450	27.5550	31.9000	100.00	174.50
6	32.1500	39.2700	31.9000	100.00	191.50
7	48.4650	55.3850	31.9000	100.00	206.50
8	68.7150	83.9850	31.9000	100.00	218.00
9	72.2700	88.3300	31.9000	100.00	211.00
10	57.0150	74.6850	31.9000	100.00	213.00
11	33.6150	41.0850	31.9000	100.00	193.50
12	21.8250	26.6750	31.9000	100.00	168.50

XO= 0.00 REVENUE= -40721.06 ERROR= 0

K / PERIOD	1	2	3	4	5	6	7	8	9	10
1	0.00	0.00	0.00	0.00	183.67	0.00	0.00	180.00	0.00	88.20
2	0.00	0.00	0.00	0.00	183.67	0.00	0.00	180.00	0.00	88.20
3	0.00	0.00	0.00	0.00	194.39	0.00	0.00	190.50	0.00	93.35
4	0.00	0.00	0.00	0.00	183.67	0.00	0.00	180.00	0.00	88.20
5	0.00	0.00	0.00	0.00	183.67	0.00	0.00	180.00	0.00	88.20
6	0.00	0.00	0.00	100.00	81.63	0.00	0.00	180.00	0.00	88.20
7	0.00	0.00	0.00	100.00	81.63	0.00	0.00	180.00	0.00	88.20
8	0.00	0.00	0.00	100.00	81.63	0.00	0.00	180.00	0.00	88.20
9	0.00	0.00	0.00	100.00	81.63	0.00	0.00	180.00	0.00	88.20
10	0.00	0.00	0.00	100.00	81.63	0.00	0.00	180.00	0.00	88.20
11	0.00	0.00	0.00	100.00	81.63	0.00	0.00	180.00	0.00	88.20
12	0.00	0.00	0.00	0.00	183.67	0.00	0.00	180.00	.00	88.20

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= 0.00

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LEVEL	LOSS	PROFIT
1	0.00	90.00	180.00	88.20	183.67	0.00	0.00	3.67	-2913.19
2	0.00	90.00	180.00	88.20	183.67	0.00	0.00	3.67	-2919.33
3	0.00	95.25	190.50	93.35	194.39	0.00	0.00	3.89	-3076.64
4	0.00	90.00	180.00	88.20	183.67	0.00	0.00	3.67	-2919.33
5	0.00	90.00	180.00	88.20	183.67	0.00	0.00	3.67	-3072.65
6	100.00	90.00	180.00	88.20	81.63	0.00	0.00	1.63	-3560.08
7	100.00	90.00	180.00	88.20	81.63	0.00	0.00	1.63	-3436.61
8	100.00	90.00	180.00	88.20	81.63	0.00	0.00	1.63	-3985.26
9	100.00	90.00	180.00	88.20	81.63	0.00	0.00	1.63	-4026.40
10	100.00	90.00	180.00	88.20	81.63	0.00	0.00	1.63	-4258.01
11	100.00	90.00	180.00	88.20	81.63	0.00	0.00	1.63	-3579.03
12	0.00	90.00	180.00	88.20	183.67	.00	.00	3.67	-2974.52

NET COST FOR SPPF = 40721.06
NET REVENUE FOR UTILITY = 21581.06

TABLE 38.

OPTIMUM SCHEDULE: SPPF B1

IOPT= 1 DT= 2.00 N= 12 NAME = B1
R1= 50.00 R2= 50.00 S= 461.92 EPS= .820 DEL= .820
GAMMA= .980 MEU= .960

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	21.3750	26.1250	31.9000	200.00	297.00
2	21.4200	26.1800	31.9000	200.00	278.00
3	21.3300	26.0700	31.9000	200.00	280.00
4	21.4200	26.1800	31.9000	200.00	315.00
5	22.5450	27.5550	31.9000	200.00	349.00
6	32.1500	39.2700	31.9000	200.00	383.00
7	48.4650	55.3850	31.9000	200.00	413.00
8	68.7150	83.9850	31.9000	200.00	436.00
9	72.2700	88.3300	31.9000	200.00	440.00
10	57.0150	74.6850	31.9000	200.00	426.00
11	33.6150	41.0850	31.9000	200.00	387.00
12	21.8250	26.6750	31.9000	200.00	337.00

XO= .41 REVENUE=-165586.78 ERROR= 0

PERIOD \ K	1	2	3	4	5	6	7
1	121.95	0.00	0.00	0.00	303.06	0.00	0.00
2	121.95	0.00	0.00	0.00	283.67	0.00	0.00
3	121.95	0.00	0.00	0.00	285.71	0.00	0.00
4	121.95	0.00	0.00	0.00	321.43	0.00	0.00
5	121.95	0.00	0.00	0.00	356.12	0.00	0.00
6	0.00	0.00	0.00	200.00	186.73	0.00	0.00
7	0.00	0.00	0.00	200.00	133.67	82.00	0.00
8	0.00	0.00	0.00	200.00	157.14	82.00	0.00
9	0.00	0.00	0.00	200.00	161.22	82.00	0.00
10	0.00	0.00	0.00	200.00	146.94	82.00	0.00
11	0.00	0.00	0.00	200.00	190.82	.00	0.00
12	.50	0.00	0.00	0.00	343.88	0.00	0.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= .41

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LEVEL	LOSS	PROFIT
1	0.00	0.00	297.00	0.00	425.01	100.00	100.39	28.01	-11103.45
2	0.00	0.00	278.00	0.00	405.62	100.00	196.38	27.62	-10619.25
3	0.00	0.00	280.00	0.00	407.67	100.00	288.52	27.67	-10627.84
4	0.00	0.00	315.00	0.00	443.38	100.00	376.98	28.38	-11607.68
5	0.00	0.00	349.00	0.00	478.07	100.00	461.90	29.07	-13173.32
6	200.00	0.00	383.00	0.00	186.73	0.00	443.43	3.73	-13713.07
7	200.00	0.00	413.00	0.00	133.67	-100.00	325.69	20.67	-13783.51
8	200.00	0.00	436.00	0.00	157.14	-100.00	212.66	21.14	-19577.64
9	200.00	0.00	440.00	0.00	161.22	-100.00	104.15	21.22	-20620.96
10	200.00	0.00	426.00	0.00	146.94	-100.00	-.01	20.94	-17354.12
11	200.00	0.00	387.00	0.00	190.82	-.00	-.01	3.82	-14219.69
12	0.00	0.00	337.00	0.00	344.38	.41	.40	6.97	-9186.25

NET COST FOR SPPF = 165586.78
NET REVENUE FOR UTILITY = 127306.78

TABLE 39.

OPTIMUM SCHEDULE: SPPF B2

IOPT= 1 OT= 2.00 N= 12 NAME = B2
R1= 50.00 R2= 50.00 S= 700.00 EPS= .820 OEL= .820
GAMMA= .980 MEU= .960

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	21.3750	26.1250	31.9000	200.00	297.00
2	21.4200	26.1800	31.9000	200.00	278.00
3	21.3300	26.0700	31.9000	200.00	280.00
4	21.4200	26.1800	31.9000	200.00	315.00
5	22.5450	27.5550	31.9000	200.00	349.00
6	32.1500	39.2700	31.9000	200.00	383.00
7	48.4650	55.3850	31.9000	200.00	413.00
8	68.7150	83.9850	31.9000	200.00	436.00
9	72.2700	88.3300	31.9000	200.00	440.00
10	57.0150	74.6850	31.9000	200.00	426.00
11	33.6150	41.0850	31.9000	200.00	387.00
12	21.8250	26.6750	31.9000	200.00	337.00

XO= .41 REVENUE=-165586.78 ERROR= 0

K PERIOD	1	2	3	4	5	6	7
1	121.95	0.00	0.00	0.00	303.06	0.00	0.00
2	121.95	0.00	0.00	0.00	283.67	0.00	0.00
3	121.95	0.00	0.00	0.00	285.71	0.00	0.00
4	121.95	0.00	0.00	0.00	321.43	0.00	0.00
5	121.95	0.00	0.00	0.00	356.12	0.00	0.00
6	0.00	0.00	0.00	200.00	186.73	0.00	0.00
7	0.00	0.00	0.00	200.00	133.67	82.00	0.00
8	0.00	0.00	0.00	200.00	157.14	82.00	0.00
9	0.00	0.00	0.00	200.00	161.22	82.00	0.00
10	0.00	0.00	0.00	200.00	146.94	82.00	0.00
11	0.00	0.00	0.00	200.00	190.82	.00	0.00
12	.50	0.00	0.00	0.00	343.88	0.00	0.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= .41

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LEVEL	LOSS	PROFIT
1	0.00	0.00	297.00	0.00	425.01	100.00	100.39	28.01	-11103.45
2	0.00	0.00	278.00	0.00	405.62	100.00	196.38	27.62	-10619.25
3	0.00	0.00	280.00	0.00	407.67	100.00	288.52	27.67	-10627.84
4	0.00	0.00	315.00	0.00	443.38	100.00	376.98	28.38	-11607.68
5	0.00	0.00	349.00	0.00	478.07	100.00	461.90	29.07	-13173.32
6	200.00	0.00	383.00	0.00	186.73	0.00	443.43	3.73	-13713.07
7	200.00	0.00	413.00	0.00	133.67	-100.00	325.69	20.67	-13783.51
8	200.00	0.00	436.00	0.00	157.14	-100.00	212.66	21.14	-19577.64
9	200.00	0.00	440.00	0.00	161.22	-100.00	104.15	21.22	-20620.96
10	200.00	0.00	426.00	0.00	146.94	-100.00	-.01	20.94	-17354.12
11	200.00	0.00	387.00	0.00	190.82	-.00	-.01	3.82	-14219.69
12	0.00	0.00	337.00	0.00	344.38	.41	.40	6.97	-9186.25

NET COST FOR SPPF = 165586.78
NET REVENUE FOR UTILITY = 127306.78

TABLE 40.

OPTIMUM SCHEDULE: SPPF B3

IOPT= 3 DT= 2.00 N= 12 NAME = B3
R1= 50.00 R2= 50.00 S= 461.92 EPS= .820 DEL= .820
GAMMA= .980 MEU= .960
UT= 4341.00 UL= 360.00 UH= 480.00

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	21.3750	26.1250	31.9000	200.00	297.00
2	21.4200	26.1800	31.9000	200.00	278.00
3	21.3300	26.0700	31.9000	200.00	280.00
4	21.4200	26.1800	31.9000	200.00	315.00
5	22.5450	27:5550	31.9000	200.00	349.00
6	32.1500	39.2700	31.9000	200.00	383.00
7	48.4650	55.3850	31.9000	200.00	413.00
8	68.7150	83.9850	31.9000	200.00	436.00
9	72.2700	88.3300	31.9000	200.00	440.00
10	57.0150	74.6850	31.9000	200.00	426.00
11	33.6150	41.0850	31.9000	200.00	387.00
12	21.8250	26.6750	31.9000	200.00	337.00

XO= .41 REVENUE=-150478.68 ERROR= 0

K PERIOD	1	2	3	4	5	6	7	8
1	121.95	0.00	0.00	0.00	367.35	0.00	0.00	360.00
2	121.95	0.00	0.00	0.00	367.35	0.00	0.00	360.00
3	121.95	0.00	0.00	0.00	388.78	0.00	0.00	381.00
4	121.95	0.00	0.00	0.00	367.35	0.00	0.00	360.00
5	121.95	0.00	0.00	0.00	367.35	0.00	0.00	360.00
6	0.00	0.00	0.00	200.00	163.27	0.00	0.00	360.00
7	0.00	0.00	0.00	200.00	79.59	82.00	0.00	360.00
8	0.00	0.00	0.00	200.00	79.59	82.00	0.00	360.00
9	0.00	0.00	0.00	200.00	79.59	82.00	0.00	360.00
10	0.00	0.00	0.00	200.00	79.59	82.00	0.00	360.00
11	0.00	0.00	0.00	200.00	163.27	.00	0.00	360.00
12	.50	0.00	0.00	0.00	367.35	0.00	0.00	360.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= .41

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LEVEL	LOSS	PROFIT
1	0.00	0.00	360.00	0.00	489.30	100.00	100.39	29.30	-12782.91
2	0.00	0.00	360.00	0.00	489.30	100.00	196.38	29.30	-12809.83
3	0.00	0.00	381.00	0.00	510.73	100.00	288.52	29.73	-13314.65
4	0.00	0.00	360.00	0.00	489.30	100.00	376.98	29.30	-12809.83
5	0.00	0.00	360.00	0.00	489.30	100.00	461.90	29.30	-13482.61
6	200.00	0.00	360.00	0.00	163.27	0.00	443.43	3.27	-12791.43
7	200.00	0.00	360.00	0.00	79.59	-100.00	325.69	19.59	-10788.19
8	200.00	0.00	360.00	0.00	79.59	-100.00	212.66	19.59	-13064.52
9	200.00	0.00	360.00	0.00	79.59	-100.00	104.15	19.59	-13410.35
10	200.00	0.00	360.00	0.00	79.59	-100.00	-.01	19.59	-12324.32
11	200.00	0.00	360.00	0.00	163.27	-.00	-.01	3.27	-13087.76
12	0.00	0.00	360.00	0.00	367.85	.41	.40	7.44	-9812.29

NET COST FOR SPPF = 150478.68
NET REVENUE FOR UTILITY = 112198.68

TABLE 41.

OPTIMUM SCHDULE: SPPF B4

IOPT= 3 DT= 2.00 N= 12 NAME = B4
R1= 50.00 R2= 50.00 S= 461.92 EPS= .820 DEL= .820
GAMMA= .980 MEU= .960
UT= 4341.00 UL= 240.00 UH= 480.00

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	21.3750	26.1250	31.9000	200.00	297.00
2	21.4200	26.1800	31.9000	200.00	278.00
3	21.3300	26.0700	31.9000	200.00	280.00
4	21.4200	26.1800	31.9000	200.00	315.00
5	22.5450	27.5550	31.9000	200.00	349.00
6	32.1500	39.2700	31.9000	200.00	383.00
7	48.4650	55.3850	31.9000	200.00	413.00
8	68.7150	83.9850	31.9000	200.00	436.00
9	72.2700	88.3300	31.9000	200.00	440.00
10	57.0150	74.6850	31.9000	200.00	426.00
11	33.6150	41.0850	31.9000	200.00	387.00
12	21.8250	26.6750	31.9000	200.00	337.00

XO= 0.00 REVENUE=-125896.82 ERROR= 0

K PERIOD	1	2	3	4	5	6	7	8
1	42.65	0.00	0.00	0.00	489.80	0.00	0.00	480.00
2	121.95	0.00	0.00	0.00	489.80	0.00	0.00	480.00
3	121.95	0.00	0.00	0.00	489.80	0.00	0.00	480.00
4	121.95	0.00	0.00	0.00	489.80	0.00	0.00	480.00
5	121.95	0.00	0.00	0.00	489.80	0.00	0.00	480.00
6	0.00	0.00	0.00	200.00	62.24	0.00	0.00	261.00
7	0.00	0.00	0.00	200.00	0.00	40.00	0.00	240.00
8	0.00	0.00	0.00	200.00	0.00	40.00	42.00	240.00
9	0.00	0.00	0.00	200.00	0.00	40.00	42.00	240.00
10	0.00	0.00	0.00	200.00	0.00	40.00	42.00	240.00
11	0.00	0.00	0.00	200.00	40.82	.00	0.00	240.00
12	.00	0.00	0.00	0.00	489.80	0.00	0.00	480.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= 0.00

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LEVEL	LOSS	PROFIT
1	0.00	0.00	480.00	0.00	532.45	34.97	34.97	17.47	-13910.20
2	0.00	0.00	480.00	0.00	611.75	100.00	133.58	31.75	-16015.54
3	0.00	0.00	480.00	0.00	611.75	100.00	228.23	31.75	-15948.25
4	0.00	0.00	480.00	0.00	611.75	100.00	319.10	31.75	-16015.54
5	0.00	0.00	480.00	0.00	611.75	100.00	406.34	31.75	-16856.69
6	200.00	0.00	261.00	0.00	62.24	0.00	390.09	1.24	-8824.36
7	200.00	0.00	240.00	0.00	0.00	-48.78	325.70	8.78	-6380.00
8	200.00	0.00	240.00	42.00	0.00	-100.00	212.67	18.00	-3493.97
9	200.00	0.00	240.00	42.00	0.00	-100.00	104.17	18.00	-3344.66
10	200.00	0.00	240.00	42.00	0.00	-100.00	-.00	18.00	-3985.37
11	200.00	0.00	240.00	0.00	40.82	-.00	-.00	.82	-8056.94
12	0.00	0.00	480.00	0.00	489.80	.00	.00	9.80	-13065.31

NET COST FOR SPPF = 125896.82
NET REVENUE FOR UTILITY = 87616.82

TABLE 42.

OPTIMUM SCHEDULE: SPPF B5

IOPT= 5 DT= 2.00 N= 12 NAME = B5
R1= 50.00 R2= 50.00 S= 461.92 EPS= .820 DEL= .820
BETA= .500 GAMMA= .980 MEU= .960
UT= 4341.00 UL= 240.00 UH= 480.00

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	21.3750	26.1250	31.9000	200.00	297.00
2	21.4200	26.1800	31.9000	200.00	278.00
3	21.3300	26.0700	31.9000	200.00	280.00
4	21.4200	26.1800	31.9000	200.00	315.00
5	22.5450	27.5550	31.9000	200.00	349.00
6	32.1500	39.2700	31.9000	200.00	383.00
7	48.4650	55.3850	31.9000	200.00	413.00
8	68.7150	83.9850	31.9000	200.00	436.00
9	72.2700	88.3300	31.9000	200.00	440.00
10	57.0150	74.6850	31.9000	200.00	426.00
11	33.6150	41.0850	31.9000	200.00	387.00
12	21.8250	26.6750	31.9000	200.00	337.00

XO= .41 REVENUE= -55145.68 ERROR= 0

K / PERIOD	1	2	3	4	5	6	7	8	9	10
1	0.00	0.00	0.00	0.00	489.80	0.00	0.00	480.00	121.95	115.69
2	0.00	0.00	0.00	0.00	489.80	0.00	0.00	480.00	121.95	115.69
3	0.00	0.00	0.00	0.00	489.80	0.00	0.00	480.00	121.95	115.69
4	0.00	0.00	0.00	0.00	489.80	0.00	0.00	480.00	121.95	115.69
5	0.00	0.00	0.00	0.00	489.80	0.00	0.00	480.00	121.95	115.69
6	0.00	0.00	0.00	200.00	62.24	.00	0.00	261.00	0.00	127.89
7	0.00	0.00	0.00	200.00	0.00	40.00	42.00	240.00	0.00	117.60
8	0.00	0.00	0.00	200.00	0.00	40.00	42.00	240.00	0.00	117.60
9	0.00	0.00	0.00	200.00	0.00	40.00	42.00	240.00	0.00	117.60
10	0.00	0.00	0.00	200.00	0.00	40.00	42.00	240.00	0.00	117.60
11	0.00	0.00	0.00	200.00	40.82	.00	0.00	240.00	0.00	117.60
12	0.00	0.00	0.00	0.00	489.80	0.00	0.00	480.00	.51	234.71

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= .41

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LEVEL	LOSS	PROFIT
1	0.00	240.00	480.00	115.69	489.80	100.00	100.40	31.75	-10323.09
2	0.00	240.00	480.00	115.69	489.80	100.00	196.38	31.75	-10344.82
3	0.00	240.00	480.00	115.69	489.80	100.00	288.53	31.75	-10301.36
4	0.00	240.00	480.00	115.69	489.80	100.00	376.99	31.75	-10344.82
5	0.00	240.00	480.00	115.69	489.80	100.00	461.91	31.75	-10888.14
6	200.00	130.50	261.00	127.89	62.24	-.00	443.43	1.25	-4712.56
7	200.00	120.00	240.00	159.60	0.00	-100.00	325.69	18.00	1355.01
8	200.00	120.00	240.00	159.60	0.00	-100.00	212.66	18.00	4586.91
9	200.00	120.00	240.00	159.60	0.00	-100.00	104.15	18.00	5154.29
10	200.00	120.00	240.00	159.60	0.00	-100.00	-.01	18.00	2719.59
11	200.00	120.00	240.00	117.60	40.82	-.00	-.01	.82	-4103.81
12	0.00	240.00	480.00	234.71	489.80	.41	.40	9.89	-7942.87

NET COST FOR SPPF = 55145.68
NET REVENUE FOR UTILITY = 16865.68

TABLE 43.

OPTIMUM SCHEDULE: SPPF C1

IOPT= 1 DT= 2.00 N= 12 NAME = C1
R1= 50.00 R2= 50.00 S= 461.92 EPS= .820 DEL= .820
GAMMA= .980 MEU= .960

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	21.3750	26.1250	31.9000	200.00	445.50
2	21.4200	26.1800	31.9000	200.00	417.00
3	21.3300	26.0700	31.9000	200.00	420.00
4	21.4200	26.1800	31.9000	200.00	472.50
5	22.5450	27.5550	31.9000	200.00	523.50
6	32.1500	39.2700	31.9000	200.00	574.50
7	48.4650	55.3850	31.9000	200.00	619.50
8	68.7150	83.9850	31.9000	200.00	654.00
9	72.2700	88.3300	31.9000	200.00	660.00
10	57.0150	74.6850	31.9000	200.00	639.00
11	33.6150	41.0850	31.9000	200.00	580.50
12	21.8250	26.6750	31.9000	200.00	505.50

XO= .41 REVENUE=-272883.94 ERROR= 0

K PERIOD	1	2	3	4	5	6	7
1	121.95	0.00	0.00	0.00	454.59	0.00	0.00
2	121.95	0.00	0.00	0.00	425.51	0.00	0.00
3	121.95	0.00	0.00	0.00	428.57	0.00	0.00
4	121.95	0.00	0.00	0.00	482.14	0.00	0.00
5	121.95	0.00	0.00	0.00	534.18	0.00	0.00
6	0.00	0.00	0.00	200.00	382.14	0.00	0.00
7	0.00	0.00	0.00	200.00	344.39	82.00	0.00
8	0.00	0.00	0.00	200.00	379.59	82.00	0.00
9	0.00	0.00	0.00	200.00	385.71	82.00	0.00
10	0.00	0.00	0.00	200.00	364.29	82.00	0.00
11	0.00	0.00	0.00	200.00	388.27	.00	0.00
12	.50	0.00	0.00	0.00	515.82	0.00	0.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= .41

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LEVEL	LOSS	PROFIT
1	0.00	0.00	445.50	0.00	576.54	100.00	100.39	31.04	-15062.19
2	0.00	0.00	417.00	0.00	547.46	100.00	196.38	30.46	-14332.54
3	0.00	0.00	420.00	0.00	550.52	100.00	288.52	30.52	-14352.13
4	0.00	0.00	472.50	0.00	604.09	100.00	376.98	31.59	-15815.18
5	0.00	0.00	523.50	0.00	656.13	100.00	461.90	32.63	-18079.80
6	200.00	0.00	574.50	0.00	382.14	0.00	443.43	7.64	-21386.75
7	200.00	0.00	619.50	0.00	344.39	-100.00	325.69	24.89	-25453.92
8	200.00	0.00	654.00	0.00	379.59	-100.00	212.66	25.59	-38260.02
9	200.00	0.00	660.00	0.00	385.71	-100.00	104.15	25.71	-40450.14
10	200.00	0.00	639.00	0.00	364.29	-100.00	-.01	25.29	-33586.68
11	200.00	0.00	580.50	0.00	388.27	-.00	-.01	7.77	-22331.88
12	0.00	0.00	505.50	0.00	516.32	.41	.40	10.41	-13772.71

NET COST FOR SPPF = 272883.94
NET REVENUE FOR UTILITY = 234603.94

TABLE 44.

OPTIMUM SCHEDULE: SPPF C2

IOPT= 3 DT= 2.00 N= 12 NAME = C2
R1= 50.00 R2= 50.00 S= 461.57 EPS= .820 DEL= .820
GAMMA= .980 MEU= .960
UT= 6511.50 UL= 540.00 UH= 720.00

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	21.3750	26.1250	31.9000	200.00	445.50
2	21.4200	26.1800	31.9000	200.00	417.00
3	21.3300	26.0700	31.9000	200.00	420.00
4	21.4200	26.1800	31.9000	200.00	472.50
5	22.5450	27.5550	31.9000	200.00	523.50
6	32.1500	39.2700	31.9000	200.00	574.50
7	48.4650	55.3850	31.9000	200.00	619.50
8	68.7150	83.9850	31.9000	200.00	654.00
9	72.2700	88.3300	31.9000	200.00	660.00
10	57.0150	74.6850	31.9000	200.00	639.00
11	33.6150	41.0850	31.9000	200.00	580.50
12	21.8250	26.6750	31.9000	200.00	505.50

XO= .00 REVENUE=-250223.30 ERROR= 0

K / PERIOD	1	2	3	4	5	6	7	8
1	121.95	0.00	0.00	0.00	551.02	0.00	0.00	540.00
2	121.95	0.00	0.00	0.00	551.02	0.00	0.00	540.00
3	121.95	0.00	0.00	0.00	583.16	0.00	0.00	571.50
4	121.95	0.00	0.00	0.00	551.02	0.00	0.00	540.00
5	121.95	0.00	0.00	0.00	551.02	0.00	0.00	540.00
6	0.00	0.00	0.00	200.00	346.94	0.00	0.00	540.00
7	0.00	0.00	0.00	200.00	263.53	81.74	0.00	540.00
8	0.00	0.00	0.00	200.00	263.27	82.00	0.00	540.00
9	0.00	0.00	0.00	200.00	263.27	82.00	0.00	540.00
10	0.00	0.00	0.00	200.00	263.27	82.00	0.00	540.00
11	0.00	0.00	0.00	200.00	346.94	.00	0.00	540.00
12	.00	0.00	0.00	0.00	551.02	0.00	0.00	540.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= .00

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LEVEL	LOSS	PROFIT
1	0.00	0.00	540.00	0.00	672.97	100.00	100.00	32.97	-17581.38
2	0.00	0.00	540.00	0.00	672.97	100.00	196.00	32.97	-17618.40
3	0.00	0.00	571.50	0.00	705.11	100.00	288.16	33.61	-18382.33
4	0.00	0.00	540.00	0.00	672.97	100.00	376.64	32.97	-17618.40
5	0.00	0.00	540.00	0.00	672.97	100.00	461.57	32.97	-18543.73
6	200.00	0.00	540.00	0.00	346.94	0.00	443.11	6.94	-20004.29
7	200.00	0.00	540.00	0.00	263.53	-99.68	325.70	23.21	-20975.72
8	200.00	0.00	540.00	0.00	263.27	-100.00	212.67	23.27	-28490.34
9	200.00	0.00	540.00	0.00	263.27	-100.00	104.17	23.27	-29634.22
10	200.00	0.00	540.00	0.00	263.27	-100.00	-.00	23.27	-26041.97
11	200.00	0.00	540.00	0.00	346.94	-.00	-.00	6.94	-20633.98
12	0.00	0.00	540.00	0.00	551.02	.00	.00	11.02	-14698.54

NET COST FOR SPPF = 250223.30
NET REVENUE FOR UTILITY = 211943.30

TABLE 45.

OPTIMUM SCHEDULE: SPPF C3

IOPT= 3 DT= 2.00 N= 12 NAME = C3
R1= 50.00 R2= 50.00 S= 461.57 EPS= .820 DEL= .820
GAMMA= .980 MEU= .960
UT= 6511.50 UL= 360.00 UH= 720.00

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	21.3750	26.1250	31.9000	200.00	445.50
2	21.4200	26.1800	31.9000	200.00	417.00
3	21.3300	26.0700	31.9000	200.00	420.00
4	21.4200	26.1800	31.9000	200.00	472.50
5	22.5450	27.5550	31.9000	200.00	523.50
6	32.1500	39.2700	31.9000	200.00	574.50
7	48.4650	55.3850	31.9000	200.00	619.50
8	68.7150	83.9850	31.9000	200.00	654.00
9	72.2700	88.3300	31.9000	200.00	660.00
10	57.0150	74.6850	31.9000	200.00	639.00
11	33.6150	41.0850	31.9000	200.00	580.50
12	21.8250	26.6750	31.9000	200.00	505.50

XO= .00 REVENUE=-209512.99 ERROR= 0

PERIOD \ K	1	2	3	4	5	6	7	8
1	121.95	0.00	0.00	0.00	734.69	0.00	0.00	720.00
2	121.95	0.00	0.00	0.00	734.69	0.00	0.00	720.00
3	121.95	0.00	0.00	0.00	734.69	0.00	0.00	720.00
4	121.95	0.00	0.00	0.00	734.69	0.00	0.00	720.00
5	121.95	0.00	0.00	0.00	734.69	0.00	0.00	720.00
6	0.00	0.00	0.00	200.00	195.41	0.00	0.00	391.50
7	0.00	0.00	0.00	200.00	79.86	81.74	0.00	360.00
8	0.00	0.00	0.00	200.00	79.59	82.00	0.00	360.00
9	0.00	0.00	0.00	200.00	79.59	82.00	0.00	360.00
10	0.00	0.00	0.00	200.00	79.59	82.00	0.00	360.00
11	0.00	0.00	0.00	200.00	163.27	.00	0.00	360.00
12	.00	0.00	0.00	0.00	734.69	0.00	0.00	720.00

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= .00

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LEVEL	LOSS	PROFIT
1	0.00	0.00	720.00	0.00	856.65	100.00	100.00	36.65	-22379.85
2	0.00	0.00	720.00	0.00	856.65	100.00	196.00	36.65	-22426.97
3	0.00	0.00	720.00	0.00	856.65	100.00	288.16	36.65	-22332.74
4	0.00	0.00	720.00	0.00	856.65	100.00	376.64	36.65	-22426.97
5	0.00	0.00	.720.00	0.00	856.65	100.00	461.57	36.65	-23604.86
6	200.00	0.00	391.50	0.00	195.41	0.00	443.11	3.91	-14053.68
7	200.00	0.00	360.00	0.00	79.86	-99.68	325.70	19.54	-10802.97
8	200.00	0.00	360.00	0.00	79.59	-100.00	212.67	19.59	-13064.52
9	200.00	0.00	360.00	0.00	79.59	-100.00	104.17	19.59	-13410.35
10	200.00	0.00	360.00	0.00	79.59	-100.00	-.00	19.59	-12324.32
11	200.00	0.00	360.00	0.00	163.27	-.00	-.00	3.27	-13087.76
12	0.00	0.00	720.00	0.00	734.70	.00	.00	14.69	-19598.03

NET COST FOR SPPF = 209512.99
NET REVENUE FOR UTILITY = 171232.99

TABLE 46.

OPTIMUM SCHEDULE: SPPF C4

IOPT= 5 DT= 2.00 N= 12 NAME = C4
R1= 50.00 R2= 50.00 S= 461.57 EPS= .820 DEL= .820
BETA= .500 GAMMA= .980 MEU= .960
UT= 6511.50 UL= 540.00 UH= 720.00

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	21.3750	26.1250	31.9000	200.00	445.50
2	21.4200	26.1800	31.9000	200.00	417.00
3	21.3300	26.0700	31.9000	200.00	420.00
4	21.4200	26.1800	31.9000	200.00	472.50
5	22.5450	27.5550	31.9000	200.00	523.50
6	32.1500	39.2700	31.9000	200.00	574.50
7	48.4650	55.3850	31.9000	200.00	619.50
8	68.7150	83.9850	31.9000	200.00	654.00
9	72.2700	88.3300	31.9000	200.00	660.00
10	57.0150	74.6850	31.9000	200.00	639.00
11	33.6150	41.0850	31.9000	200.00	580.50
12	21.8250	26.6750	31.9000	200.00	505.50

XO= .00 REVENUE=-104910.44 ERROR= 0

PERIOD \ K	1	2	3	4	5	6	7	8	9	10
1	0.00	0.00	0.00	0.00	734.69	0.00	0.00	720.00	121.95	233.29
2	0.00	0.00	0.00	0.00	734.69	0.00	0.00	720.00	121.95	233.29
3	0.00	0.00	0.00	0.00	734.69	0.00	0.00	720.00	121.95	233.29
4	0.00	0.00	0.00	0.00	734.69	0.00	0.00	720.00	121.95	233.29
5	0.00	0.00	0.00	0.00	734.69	0.00	0.00	720.00	121.95	233.29
6	0.00	0.00	0.00	200.00	195.41	0.00	0.00	391.50	.40	191.44
7	0.00	0.00	0.00	200.00	79.59	82.00	0.00	360.00	0.00	176.40
8	0.00	0.00	0.00	200.00	79.59	82.00	0.00	360.00	0.00	176.40
9	0.00	0.00	0.00	200.00	79.59	82.00	0.00	360.00	0.00	176.40
10	0.00	0.00	0.00	200.00	79.59	82.00	0.00	360.00	0.00	176.40
11	0.00	0.00	0.00	200.00	163.27	.00	0.00	360.00	0.00	176.40
12	0.00	0.00	0.00	0.00	734.69	0.00	0.00	720.00	.00	352.80

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= .00

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LEVEL	LOSS	PROFIT
1	0.00	360.00	720.00	233.29	734.69	100.00	100.00	36.65	-14207.35
2	0.00	360.00	720.00	233.29	734.69	100.00	196.00	36.65	-14237.26
3	0.00	360.00	720.00	233.29	734.69	100.00	288.16	36.65	-14177.44
4	0.00	360.00	720.00	233.29	734.69	100.00	376.64	36.65	-14237.26
5	0.00	360.00	720.00	233.29	734.69	100.00	461.57	36.65	-14985.02
6	200.00	195.75	391.50	191.44	195.41	.33	443.44	3.98	-7898.94
7	200.00	180.00	360.00	176.40	79.59	-100.00	325.70	19.59	-2238.97
8	200.00	180.00	360.00	176.40	79.59	-100.00	212.67	19.59	-943.19
9	200.00	180.00	360.00	176.40	79.59	-100.00	104.17	19.59	-661.92
10	200.00	180.00	360.00	176.40	79.59	-100.00	-.00	19.59	-2266.87
11	200.00	180.00	360.00	176.40	163.27	-.00	-.00	3.27	-7158.07
12	0.00	360.00	720.00	352.80	734.69	.00	.00	14.69	-11898.15

NET COST FOR SPPF = 104910.44
NET REVENUE FOR UTILITY = 66630.44

TABLE 47.

OPTIMUM SCHEDULE: SPPF C5

IOPT= 5 DT= 2.00 N= 12 NAME = C5
R1= 50.00 R2= 50.00 S= 461.57 EPS= .820 DEL= .820
BETA= .500 GAMMA= .980 MEU= .960
UT= 6511.50 UL= 360.00 UH= 720.00

K	P(K)	Q(K)	R(K)	G(K)	U(K)
1	21.3750	26.1250	31.9000	200.00	445.50
2	21.4200	26.1800	31.9000	200.00	417.00
3	21.3300	26.0700	31.9000	200.00	420.00
4	21.4200	26.1800	31.9000	200.00	472.50
5	22.5450	27.5550	31.9000	200.00	523.50
6	32.1500	39.2700	31.9000	200.00	574.50
7	48.4650	55.3850	31.9000	200.00	619.50
8	68.7150	83.9850	31.9000	200.00	654.00
9	72.2700	88.3300	31.9000	200.00	660.00
10	57.0150	74.6850	31.9000	200.00	639.00
11	33.6150	41.0850	31.9000	200.00	580.50
12	21.8250	26.6750	31.9000	200.00	505.50

XO= .00 REVENUE=-104910.44 ERROR= 0

K / PERIOD	1	2	3	4	5	6	7	8	9	10
1	0.00	0.00	0.00	0.00	734.69	0.00	0.00	720.00	121.95	233.29
2	0.00	0.00	0.00	0.00	734.69	0.00	0.00	720.00	121.95	233.29
3	0.00	0.00	0.00	0.00	734.69	0.00	0.00	720.00	121.95	233.29
4	0.00	0.00	0.00	0.00	734.69	0.00	0.00	720.00	121.95	233.29
5	0.00	0.00	0.00	0.00	734.69	0.00	0.00	720.00	121.95	233.29
6	0.00	0.00	0.00	200.00	195.41	0.00	0.00	391.50	.40	191.44
7	0.00	0.00	0.00	200.00	79.59	82.00	0.00	360.00	0.00	176.40
8	0.00	0.00	0.00	200.00	79.59	82.00	0.00	360.00	0.00	176.40
9	0.00	0.00	0.00	200.00	79.59	82.00	0.00	360.00	0.00	176.40
10	0.00	0.00	0.00	200.00	79.59	82.00	0.00	360.00	0.00	176.40
11	0.00	0.00	0.00	200.00	163.27	.00	0.00	360.00	0.00	176.40
12	0.00	0.00	0.00	0.00	734.69	0.00	0.00	720.00	.00	352.80

** OPTIMAL SCHEDULE FOR THE PRODUCER **

INITIAL STORAGE ENERGY LEVEL= .00

PERIOD	PRODUCE	DEP-GEN	USE	SELL	BUY	STORE	LEVEL	LOSS	PROFIT
1	0.00	360.00	720.00	233.29	734.69	100.00	100.00	36.65	-14207.35
2	0.00	360.00	720.00	233.29	734.69	100.00	196.00	36.65	-14237.26
3	0.00	360.00	720.00	233.29	734.69	100.00	288.16	36.65	-14177.44
4	0.00	360.00	720.00	233.29	734.69	100.00	376.64	36.65	-14237.26
5	0.00	360.00	720.00	233.29	734.69	100.00	461.57	36.65	-14985.02
6	200.00	195.75	391.50	191.44	195.41	.33	443.44	3.98	-7898.94
7	200.00	180.00	360.00	176.40	79.59	-100.00	325.70	19.59	-2238.97
8	200.00	180.00	360.00	176.40	79.59	-100.00	212.67	19.59	-943.19
9	200.00	180.00	360.00	176.40	79.59	-100.00	104.17	19.59	-661.92
10	200.00	180.00	360.00	176.40	79.59	-100.00	-.00	19.59	-2266.87
11	200.00	180.00	360.00	176.40	163.27	-.00	-.00	3.27	-7158.07
12	0.00	360.00	720.00	352.80	734.69	.00	.00	14.69	-11898.15

NET COST FOR SPPF = 104910.44
NET REVENUE FOR UTILITY = 66630.44

TABLE 48.

SYSTEM WIDE OPTIMUM SCHEDULE

RATE FOR NON-SPPF =51.1 ($/MWH)

NAME = NON-SPPF   DT = 2.00   UNIT = MWH

K 1	2	3	4	5	6	7	8	9	10
25245.00	23630.00	23800.00	26775.00	29665.00	32555.00	35105.00	37060.00	37400.00	36210.00
32895.00	28645.00								

REVENUE FROM NON-SPPF = 18855133.50

THE QUALITY FACTORS ARE:
QF1 = 1.5827   QF2 = .8222

NAME = A1   DT = 2.00   ID NO = 1   UNIT = MWH

K 1	2	3	4	5	6	7	8	9	10
151.53	263.78	264.81	282.67	300.01	0.00	-11.05	-64.00	-71.00	-69.00
-6.37	171.94								

NET COST FOR SPPF = 61817.92
NET REVENUE FOR UTILITY = 23809.07

NAME = A2   DT = 2.00   ID NO = 2   UNIT = MWH

K 1	2	3	4	5	6	7	8	9	10
151.53	141.84	142.86	282.67	182.94	0.00	6.63	0.00	-30.73	0.00
-6.37	171.94								

NET COST FOR SPPF = 64520.91
NET REVENUE FOR UTILITY = 26356.45

NAME = A3   DT = 2.00   ID NO = 3   UNIT = MWH

K 1	2	3	4	5	6	7	8	9	10
244.90	244.90	244.90	244.90	244.90	31.12	20.41	20.41	20.41	20.41
20.41	244.90								

NET COST FOR SPPF = 66257.89
NET REVENUE FOR UTILITY = 47117.89

NAME = A4   DT = 2.00   ID NO = 4   UNIT = MWH

K 1	2	3	4	5	6	7	8	9	10
183.67	183.67	194.39	183.67	183.67	81.63	81.63	81.63	81.63	81.63
81.63	183.67								

NET COST FOR SPPF = 79827.99
NET REVENUE FOR UTILITY = 60687.99

TABLE 48. (cont'd)

NAME = A5 DT = 2.00 ID NO = 5 UNIT = MWH

K	1	2	3	4	5	6	7	8	9	10
	95.47	95.47	101.04	95.47	95.47	-6.57	-6.57	-6.57	-6.57	-6.57
	-6.57	95.47								

NET COST FOR SPPF = 40721.06
NET REVENUE FOR UTILITY = 21581.06

NAME = B1 DT = 2.00 ID NO = 6 UNIT = MWH

K	1	2	3	4	5	6	7	8	9	10
	425.01	405.62	407.67	443.38	478.07	186.73	133.67	157.14	161.22	146.94
	190.82	344.38								

NET COST FOR SPPF = 165586.78
NET REVENUE FOR UTILITY = 127306.78

NAME = B2 DT = 2.00 ID NO = 7 UNIT = MWH

K	1	2	3	4	5	6	7	8	9	10
	425.01	405.62	407.67	443.38	478.07	186.73	133.67	157.14	161.22	146.94
	190.82	344.38								

NET COST FOR SPPF = 165586.78
NET REVENUE FOR UTILITY = 127306.78

NAME = B3 DT = 2.00 ID NO = 8 UNIT = MWH

K	1	2	3	4	5	6	7	8	9	10
	489.30	489.30	510.73	489.30	489.30	163.27	79.59	79.59	79.59	79.59
	163.27	367.85								

NET COST FOR SPPF = 150478.68
NET REVENUE FOR UTILITY = 112198.68

NAME = B4 DT = 2.00 ID NO = 9 UNIT = MWH

K	1	2	3	4	5	6	7	8	9	10
	532.45	611.75	611.75	611.75	611.75	62.24	0.00	-42.00	-42.00	-42.00
	40.82	489.80								

NET COST FOR SPPF = 125896.82
NET REVENUE FOR UTILITY = 87616.82

NAME = B5 DT = 2.00 ID NO = 10 UNIT = MWH

K	1	2	3	4	5	6	7	8	9	10
	374.11	374.11	374.11	374.11	374.11	-65.65	-159.60	-159.60	-159.60	-159.60
	-76.78	255.09								

NET COST FOR SPPF = 55145.68
NET REVENUE FOR UTILITY = 16865.68

NAME = C1 DT = 2.00 ID NO = 11 UNIT = MWH

K 1	2	3	4	5	6	7	8	9	10
576.54	547.46	550.52	604.09	656.13	382.14	344.39	379.59	385.71	364.29
388.27	516.32								

NET COST FOR SPPF = 272883.94
NET REVENUE FOR UTILITY = 234603.94

NAME = C2 DT = 2.00 ID NO = 12 UNIT = MWH

K 1	2	3	4	5	6	7	8	9	10
672.97	672.97	705.11	672.97	672.97	346.94	263.53	263.27	263.27	263.27
346.94	551.02								

NET COST FOR SPPF = 250223.30
NET REVENUE FOR UTILITY = 211943.30

NAME = C3 DT = 2.00 ID NO = 13 UNIT = MWH

K 1	2	3	4	5	6	7	8	9	10
856.65	856.65	856.65	856.65	856.65	195.41	79.86	79.59	79.59	79.59
163.27	734.70								

NET COST FOR SPPF = 209512.99
NET REVENUE FOR UTILITY = 171232.99

NAME = C4 DT = 2.00 ID NO = 14 UNIT = MWH

K 1	2	3	4	5	6	7	8	9	10
501.41	501.41	501.41	501.41	501.41	3.97	-96.81	-96.81	-96.81	-96.81
-13.13	381.90								

NET COST FOR SPPF = 104910.44
NET REVENUE FOR UTILITY = 66630.44

NAME = C5 DT = 2.00 ID NO = 15 UNIT = MWH

K 1	2	3	4	5	6	7	8	9	10
501.41	501.41	501.41	501.41	501.41	3.97	-96.81	-96.81	-96.81	-96.81
-13.13	381.90								

NET COST FOR SPPF = 104910.44
NET REVENUE FOR UTILITY = 66630.44

TABLE 48. (cont'd)

TOTAL LOADS OF SPPFS **

K 1	2	3	4	5	6	7	8	9	10
6181.96	6295.96	6375.00	6587.81	6626.86	1571.95	772.56	752.58	729.14	711.87
1463.86	5235.24								

TOTAL REVENUE FROM SPPFS = 1401888.34

** TOTAL LOAD SEEN BY UTILITY **

K 1	2	3	4	5	6	7	8	9	10
31426.96	29925.96	30175.00	33362.81	36291.86	34126.95	35877.56	37812.58	38129.14	36921.87
34358.86	33880.24								

TOTAL REVENUE FOR UTILITY = 20257021.84

THE QUALITY FACTORS ARE:
QF1 = 1.2741 QF2 = .9011

FIGURE 2.

NON SPPF SYSTEM LOAD CURVE

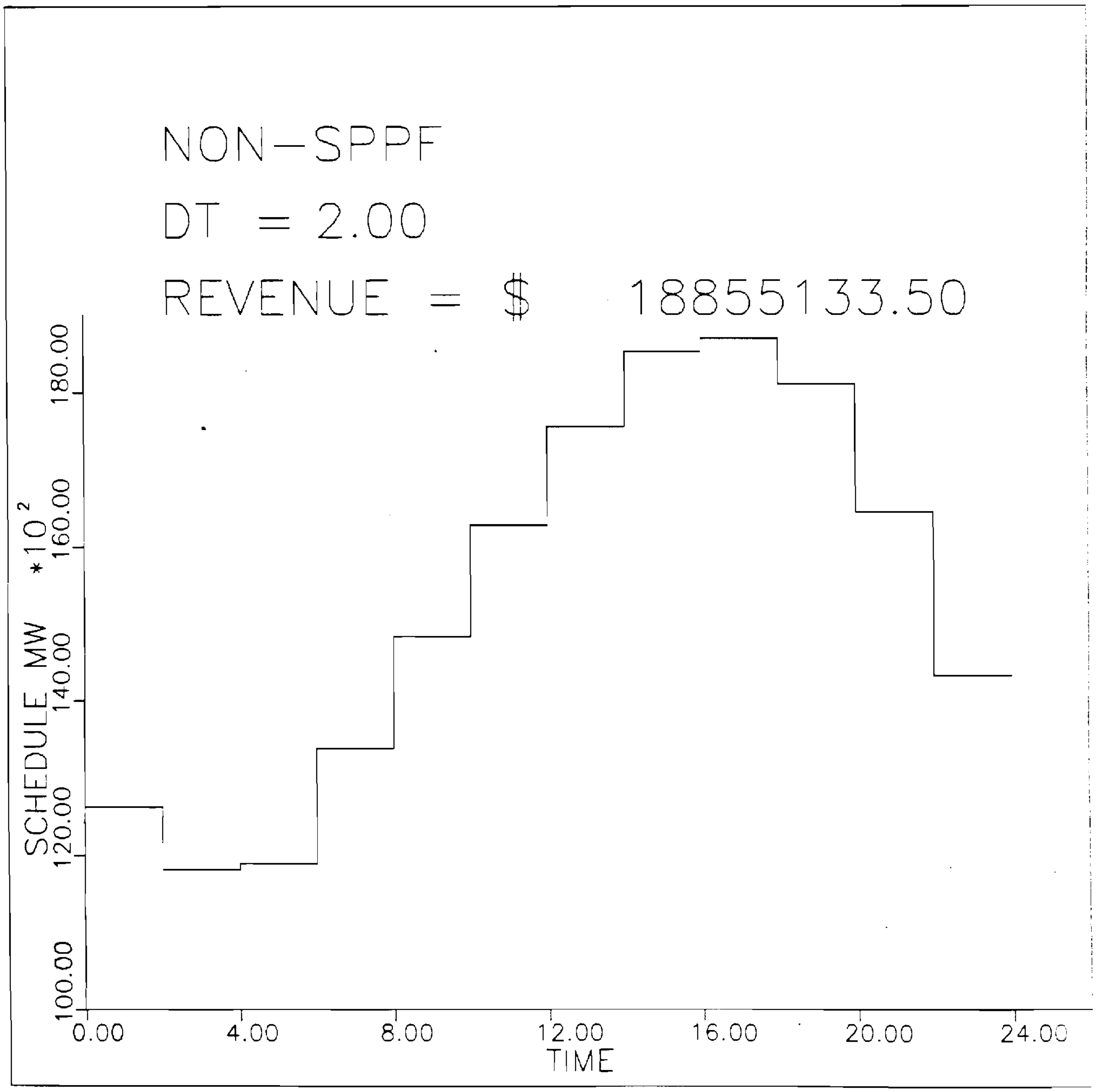


FIGURE 3.

SPPF A1 LOAD CURVE

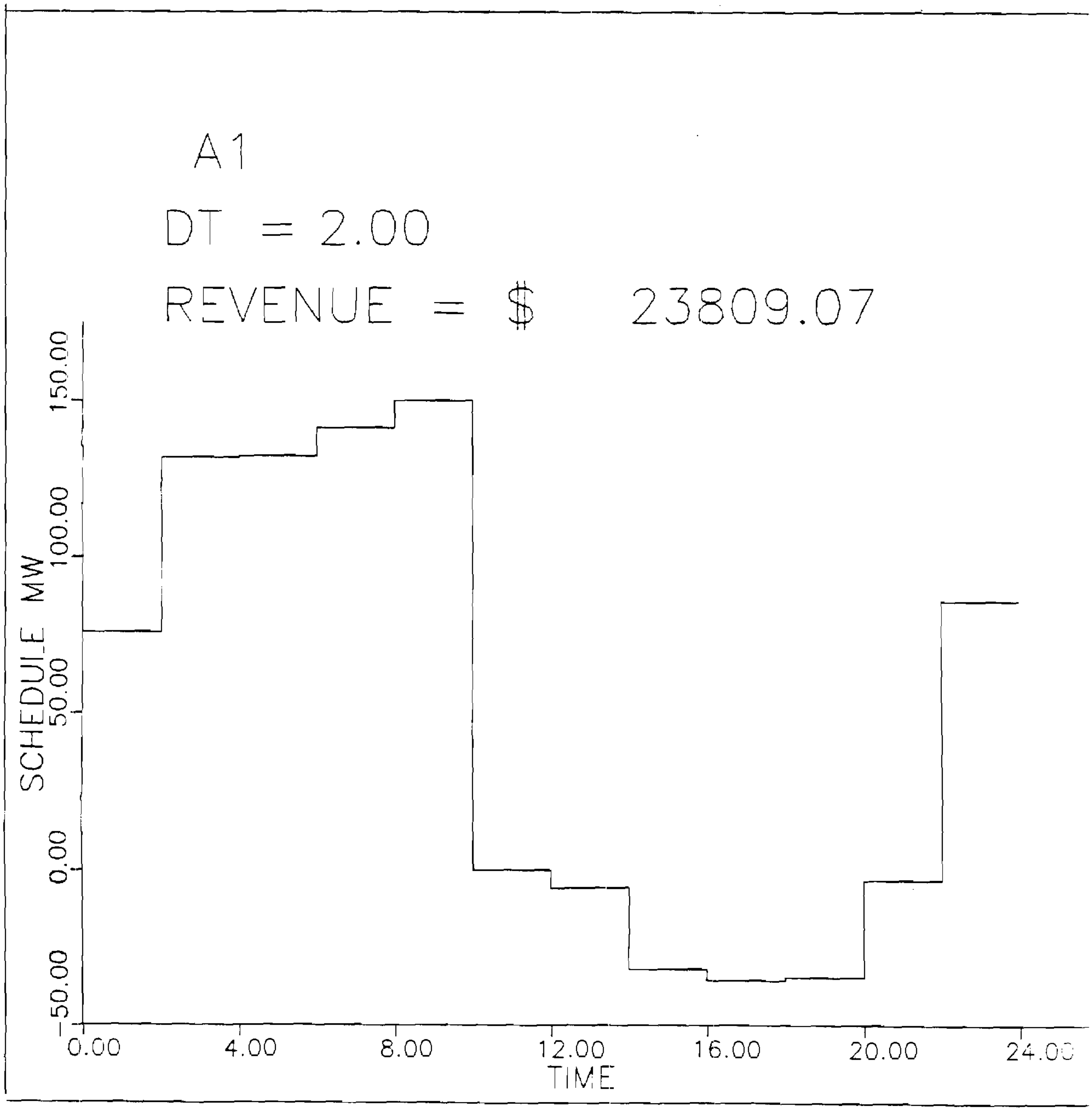


FIGURE 4.

SPPF A2 LOAD CURVE

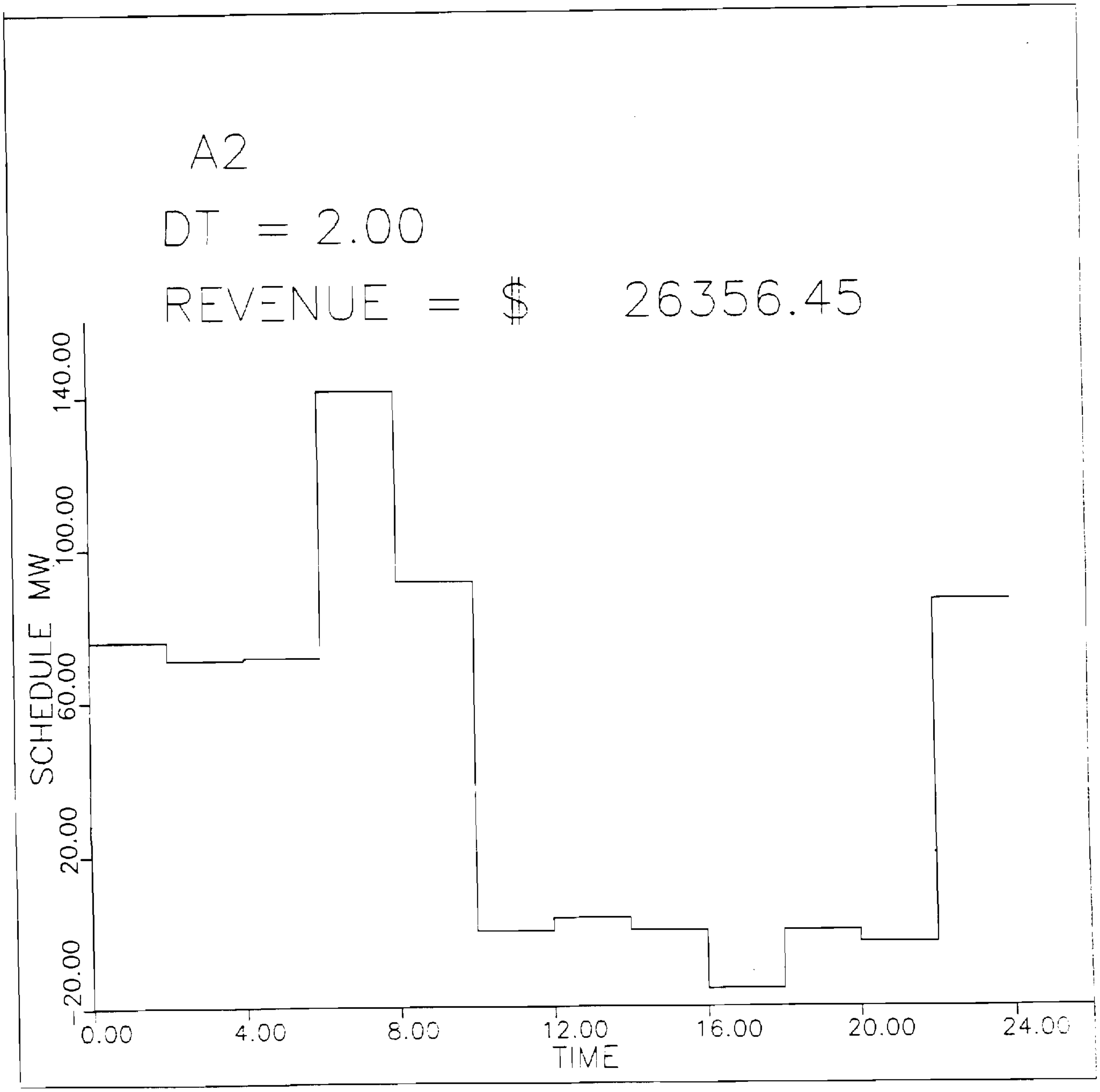


FIGURE 5.

SPPF A3 LOAD CURVE

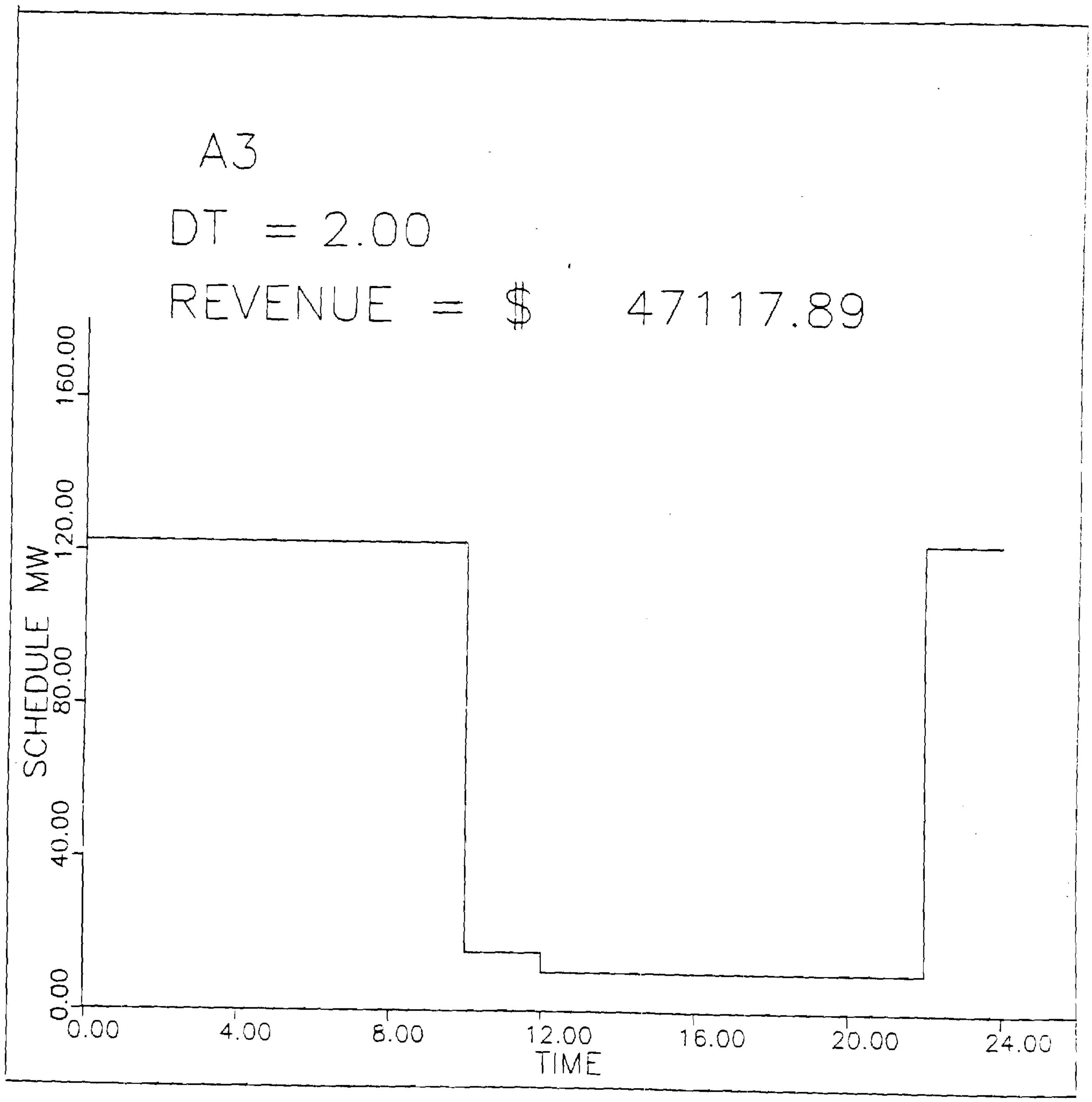


FIGURE 6.

SPPF A4 LOAD CURVE

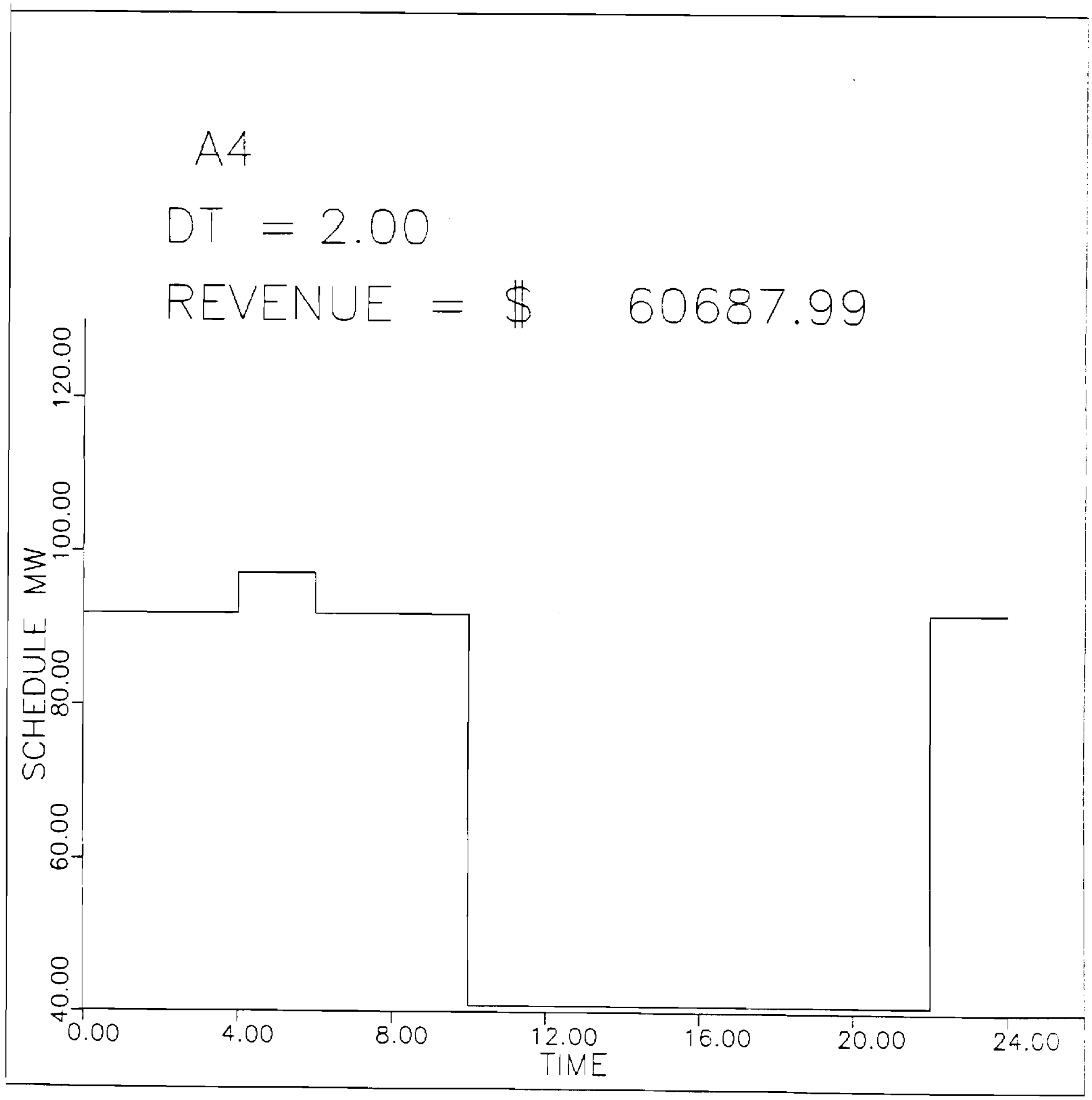


FIGURE 7.

SPPF A5 LOAD CURVE

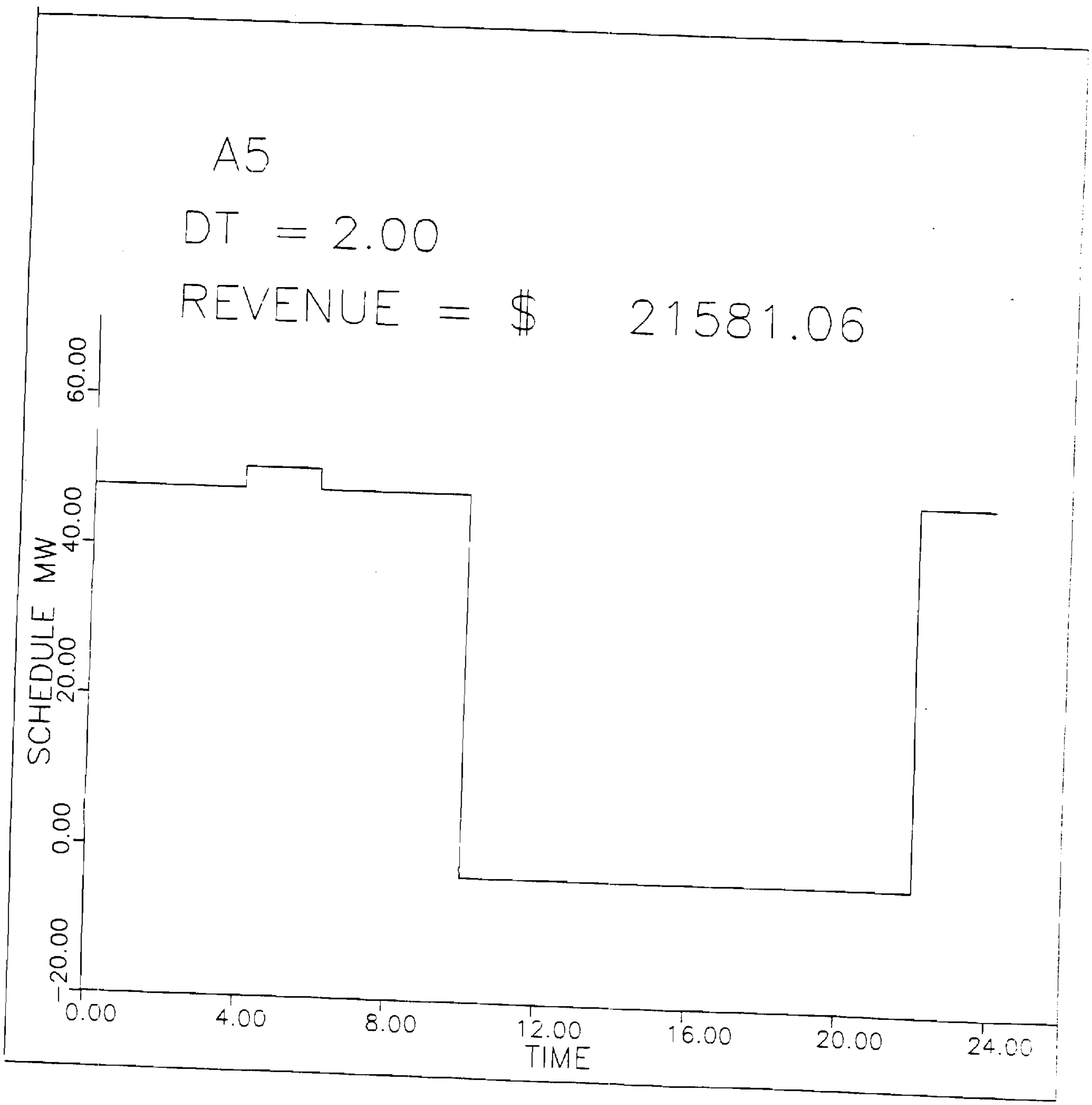


FIGURE 8.

SPPF B1 LOAD CURVE

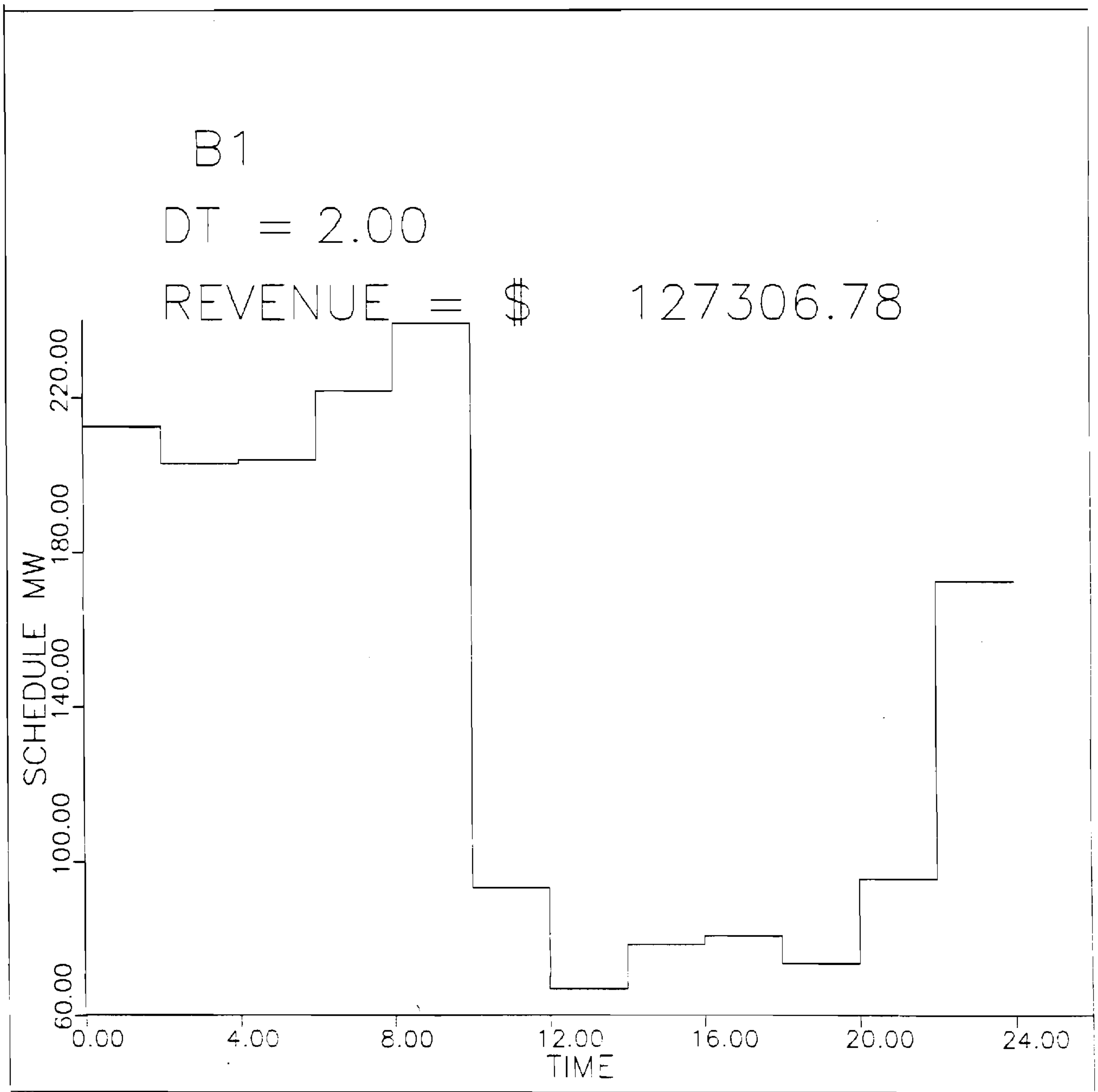


FIGURE 9.

SPPF B2 LOAD CURVE

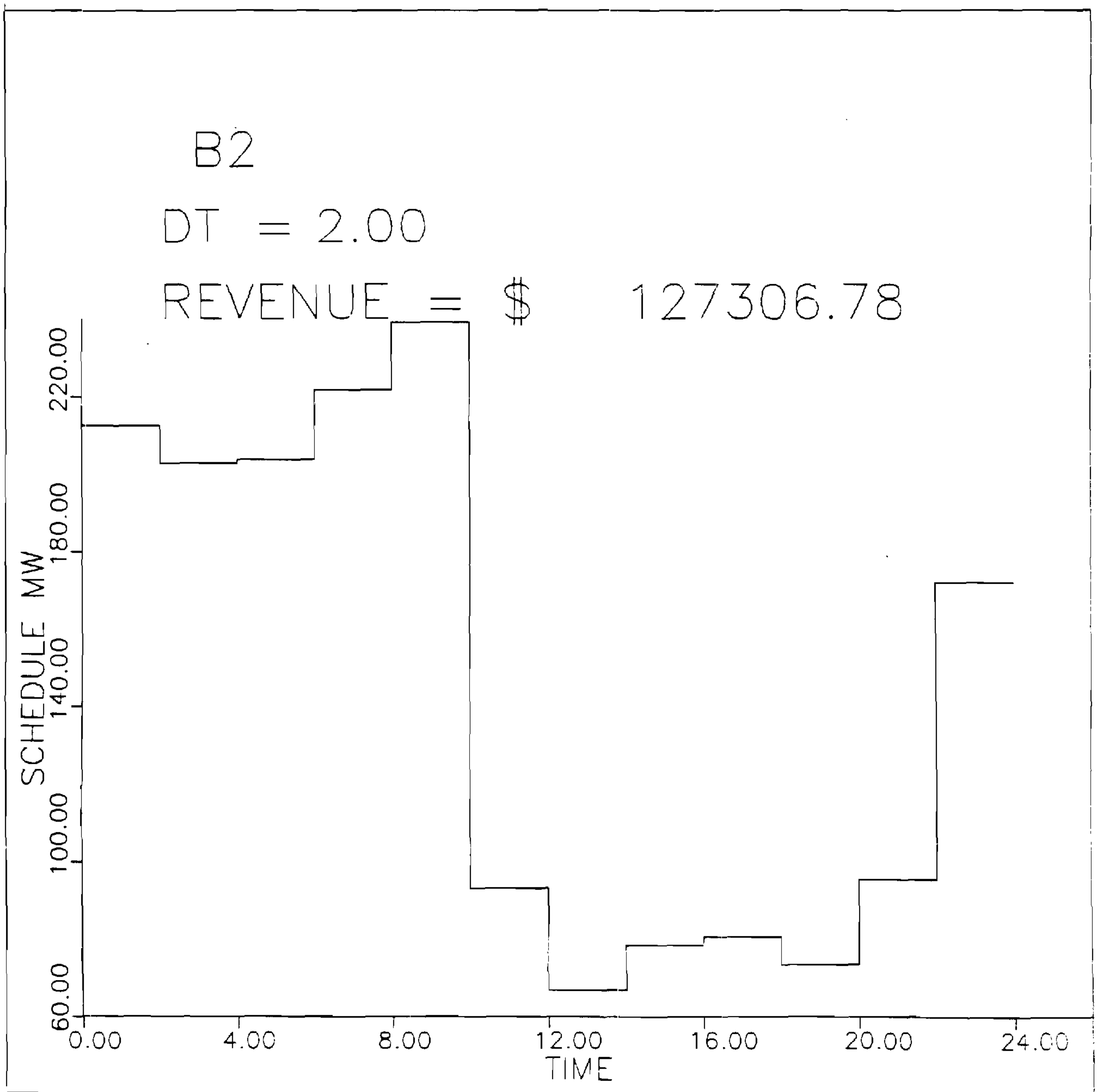


FIGURE 10.

SPPF B3 LOAD CURVE

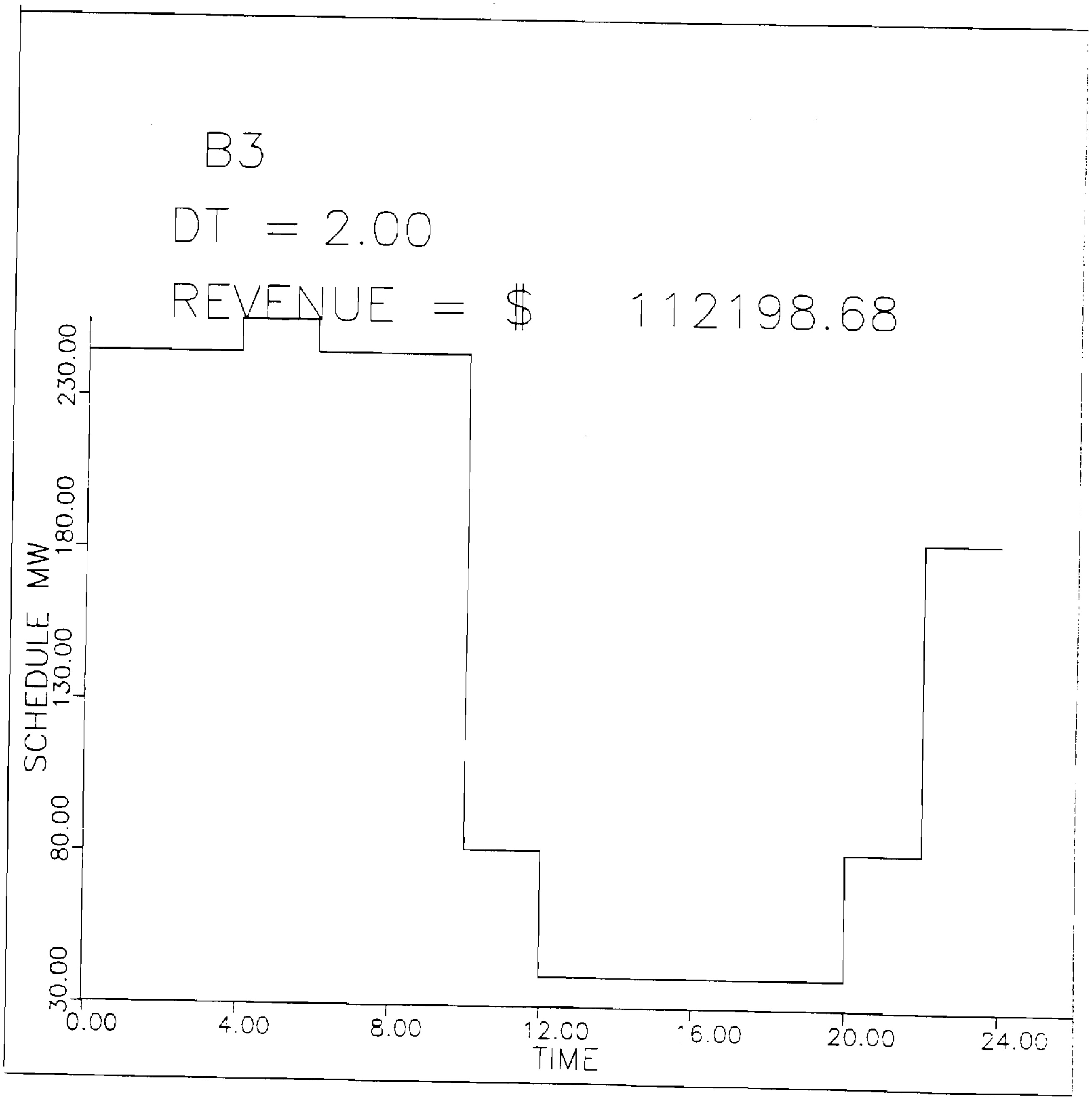


FIGURE 11.

SPPF B4 LOAD CURVE

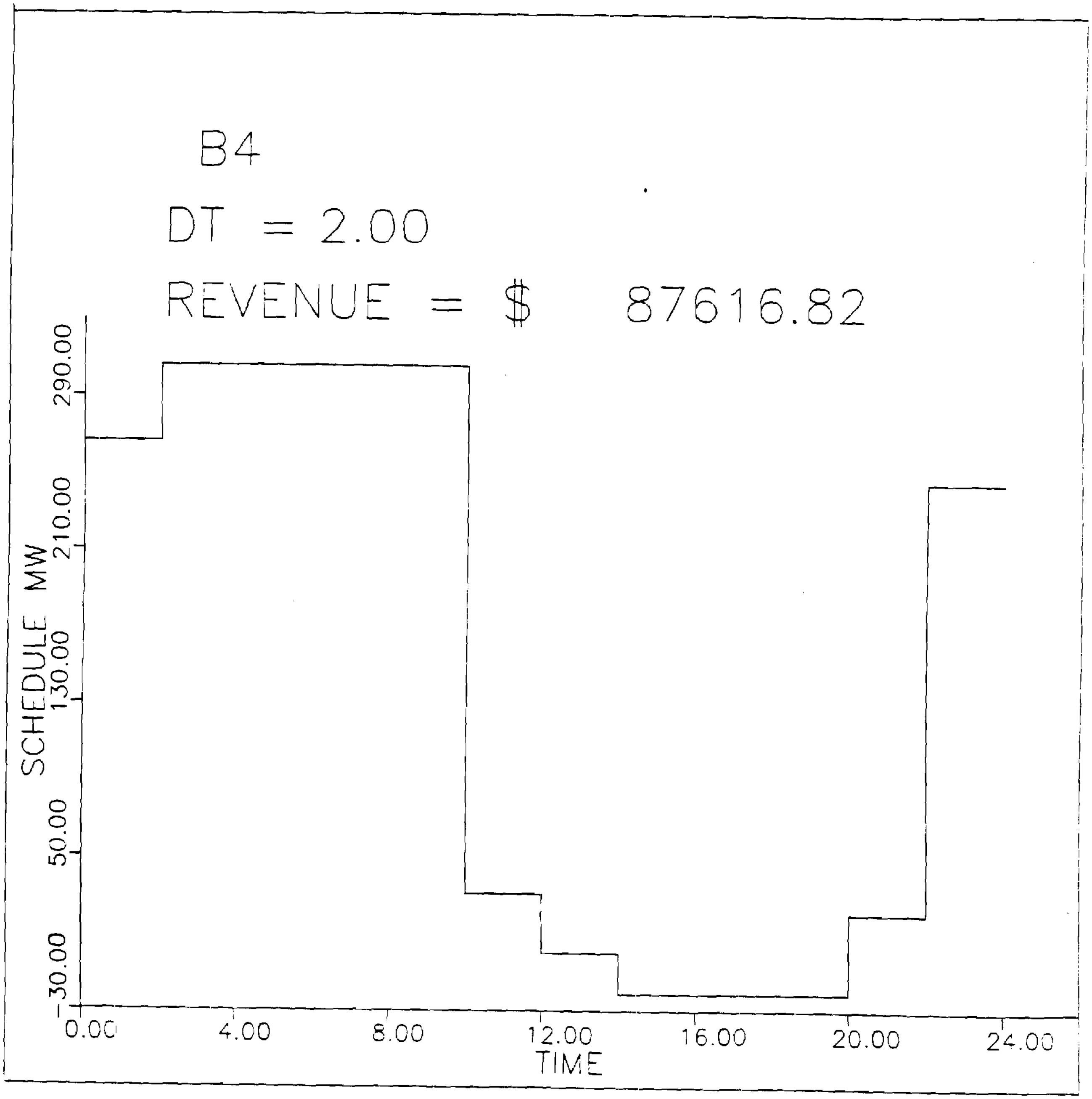


FIGURE 12.

SPPF B5 LOAD CURVE

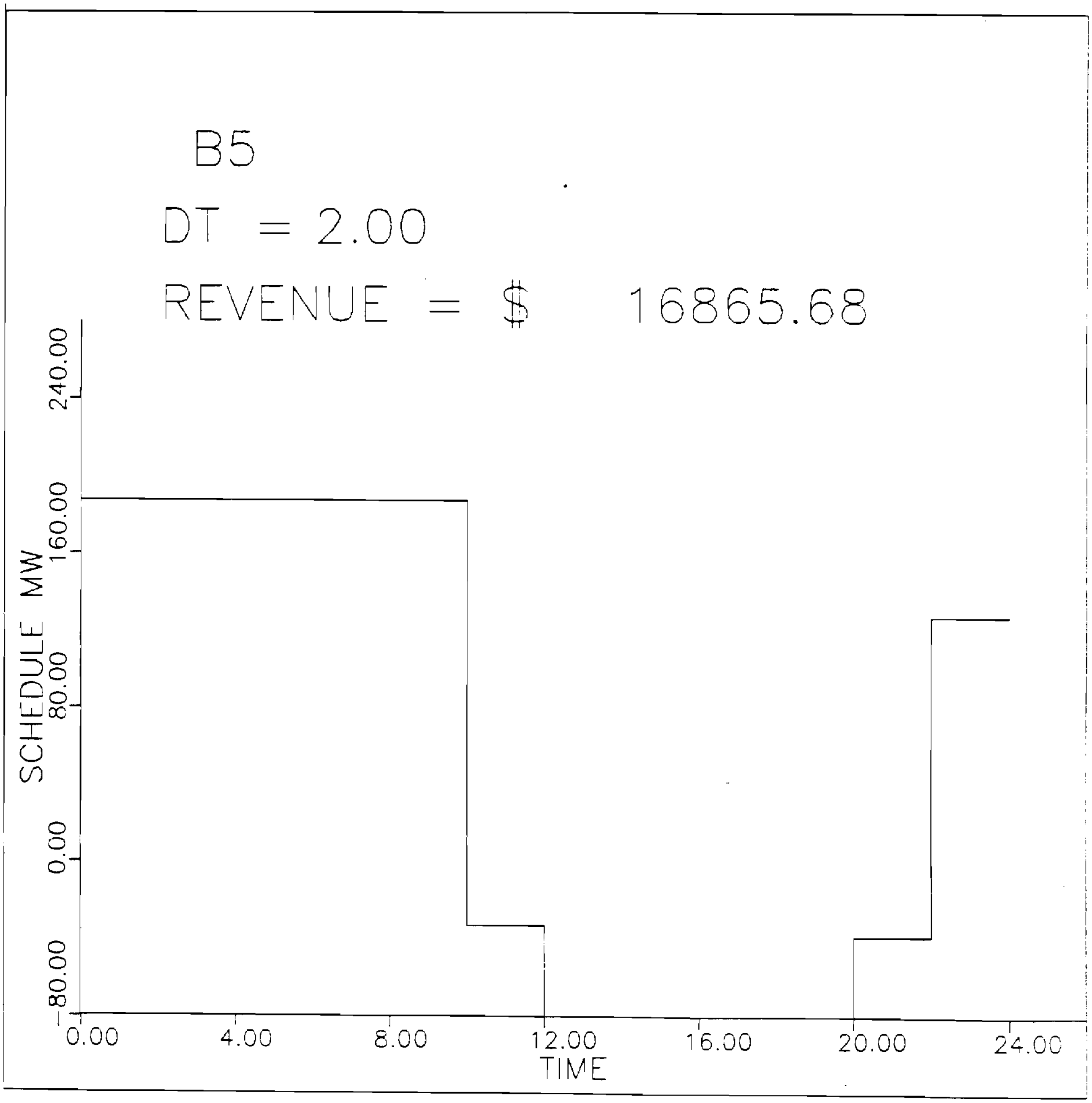


FIGURE 13.

SPPF C1 LOAD CURVE

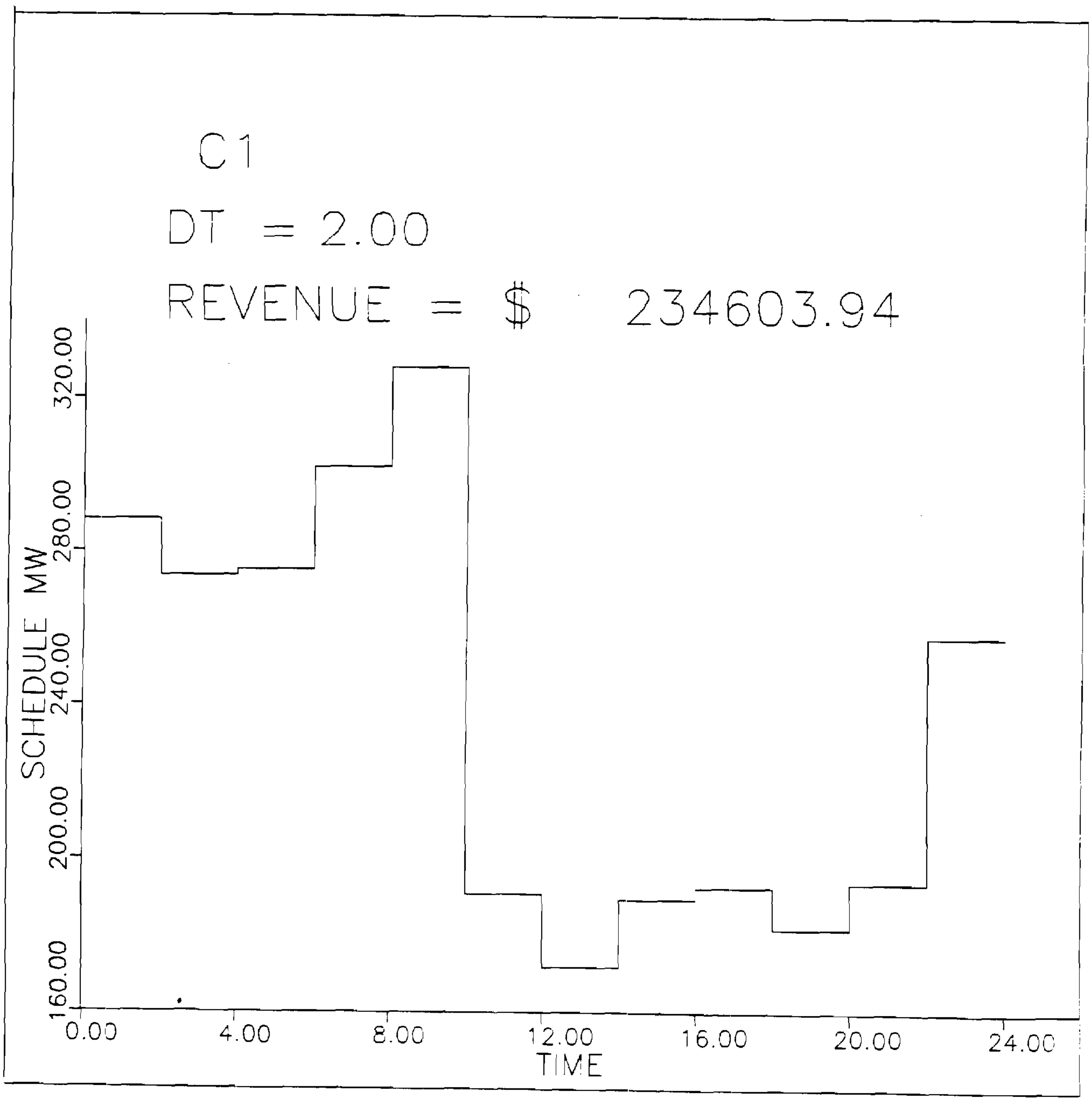


FIGURE 14.

SPPF C2 LOAD CURVE

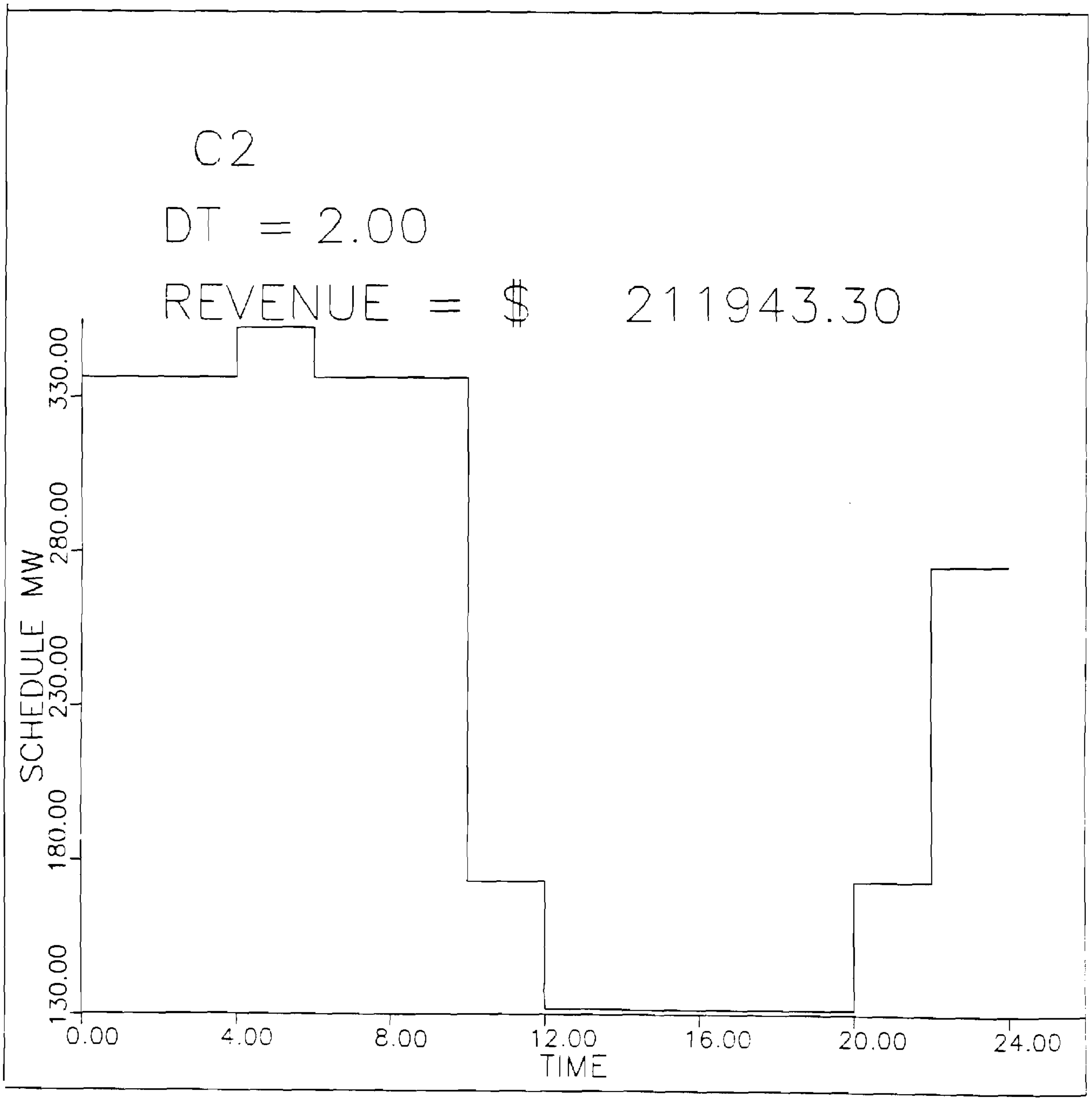


FIGURE 15.

SPPF C3 LOAD CURVE

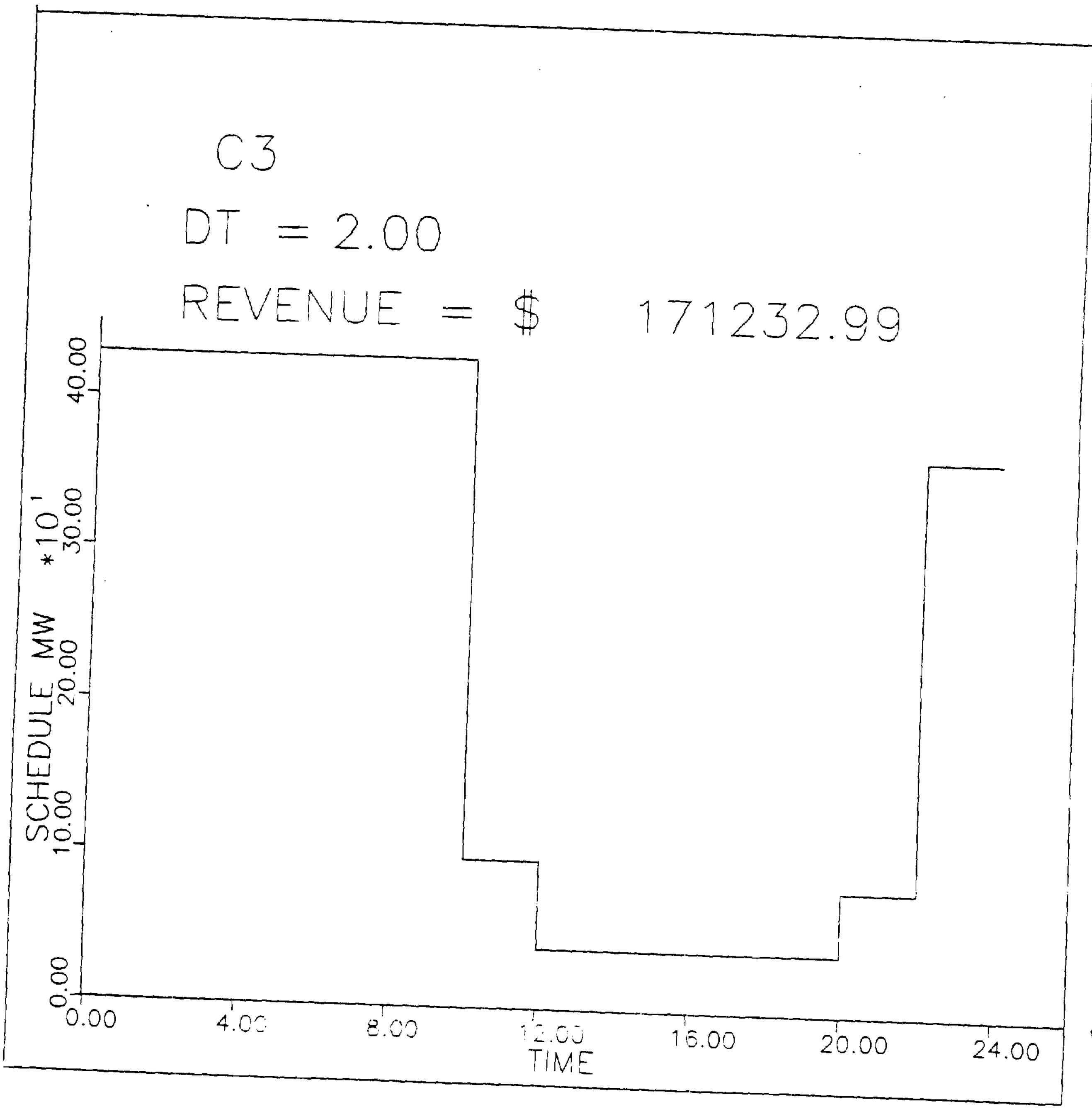


FIGURE 16.

SPPF C4 LOAD CURVE

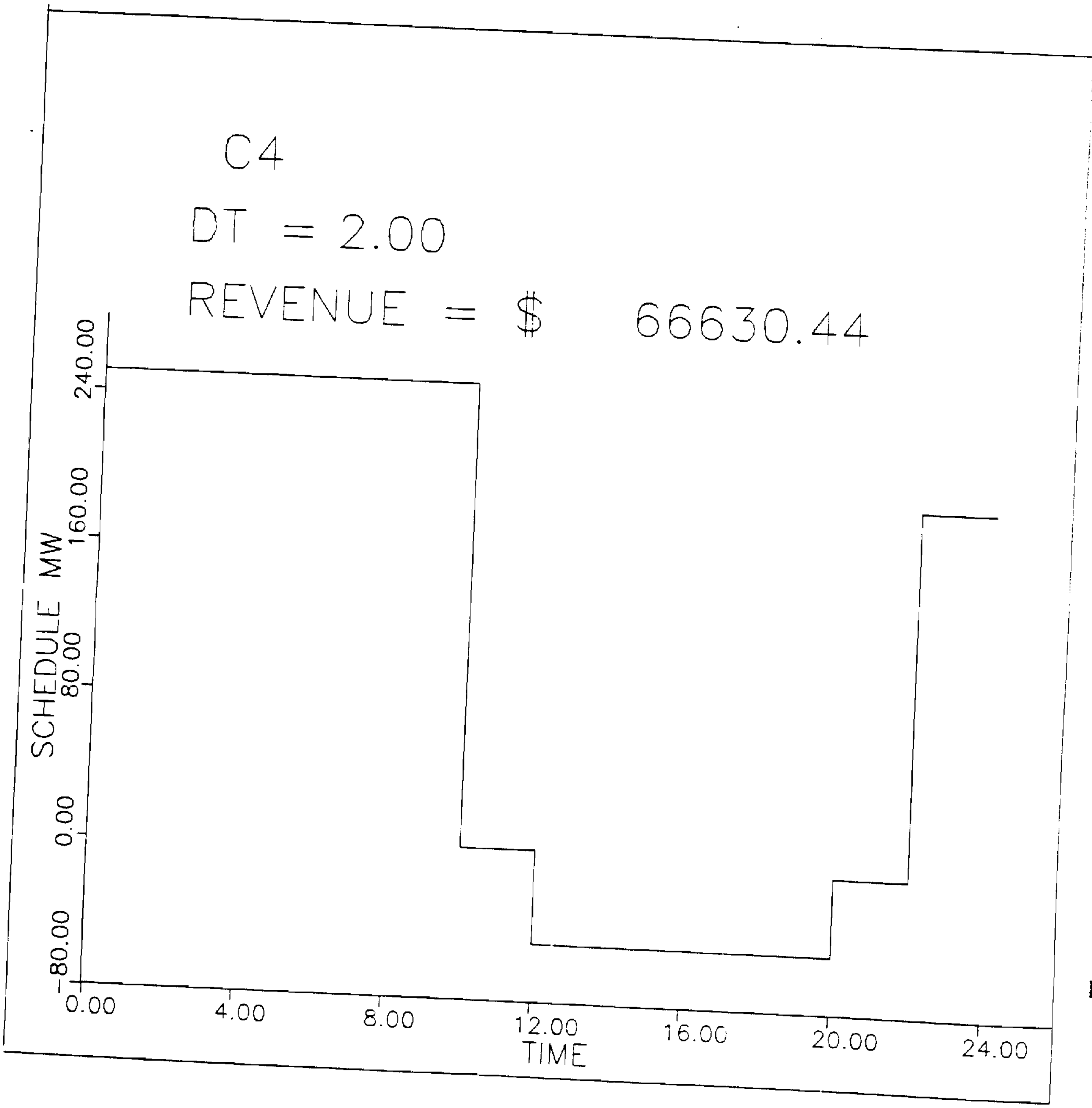


FIGURE 17.

SPPF C5 LOAD CURVE

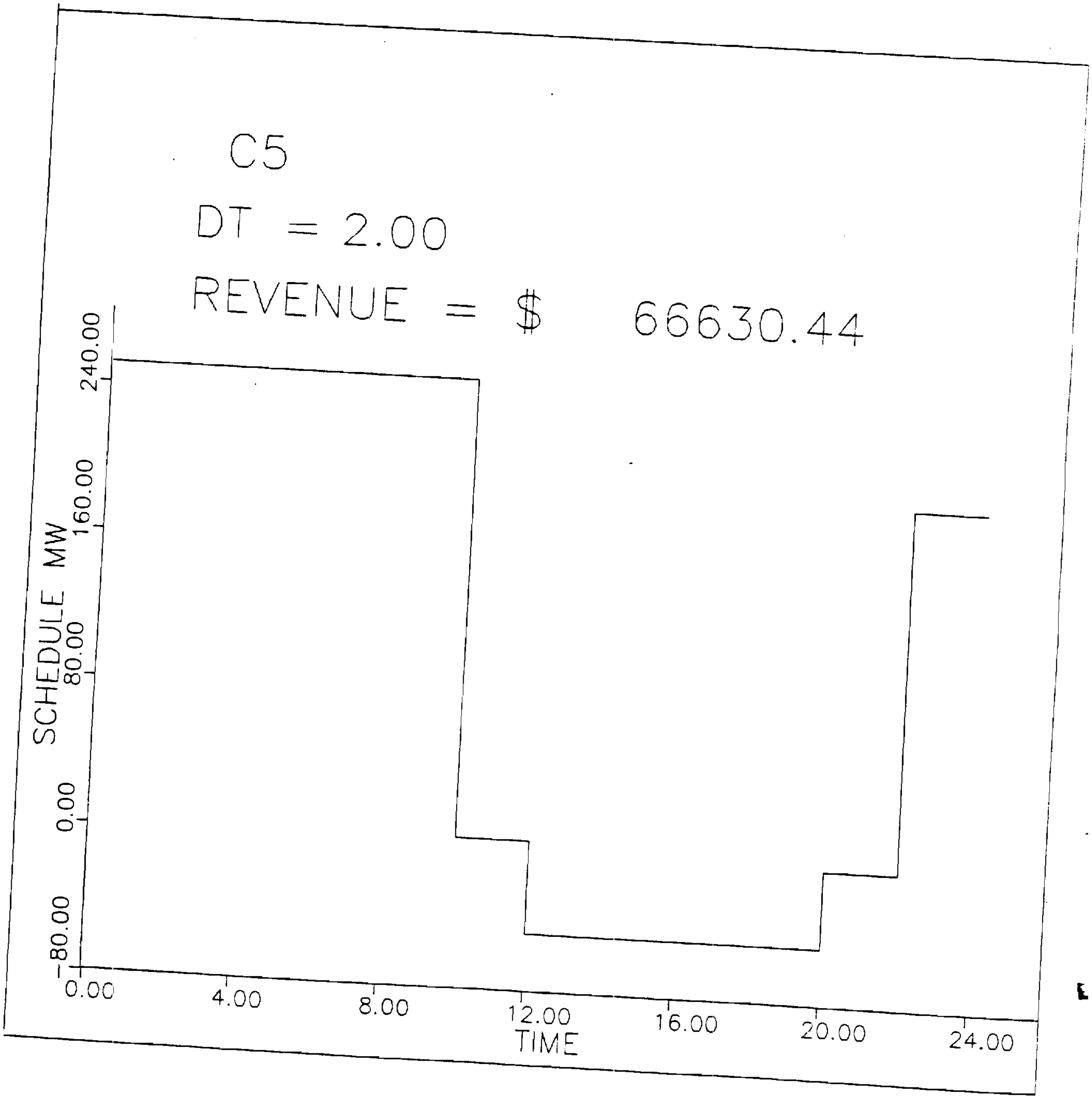


FIGURE 18.

TOTAL SPPF LOAD CURVE

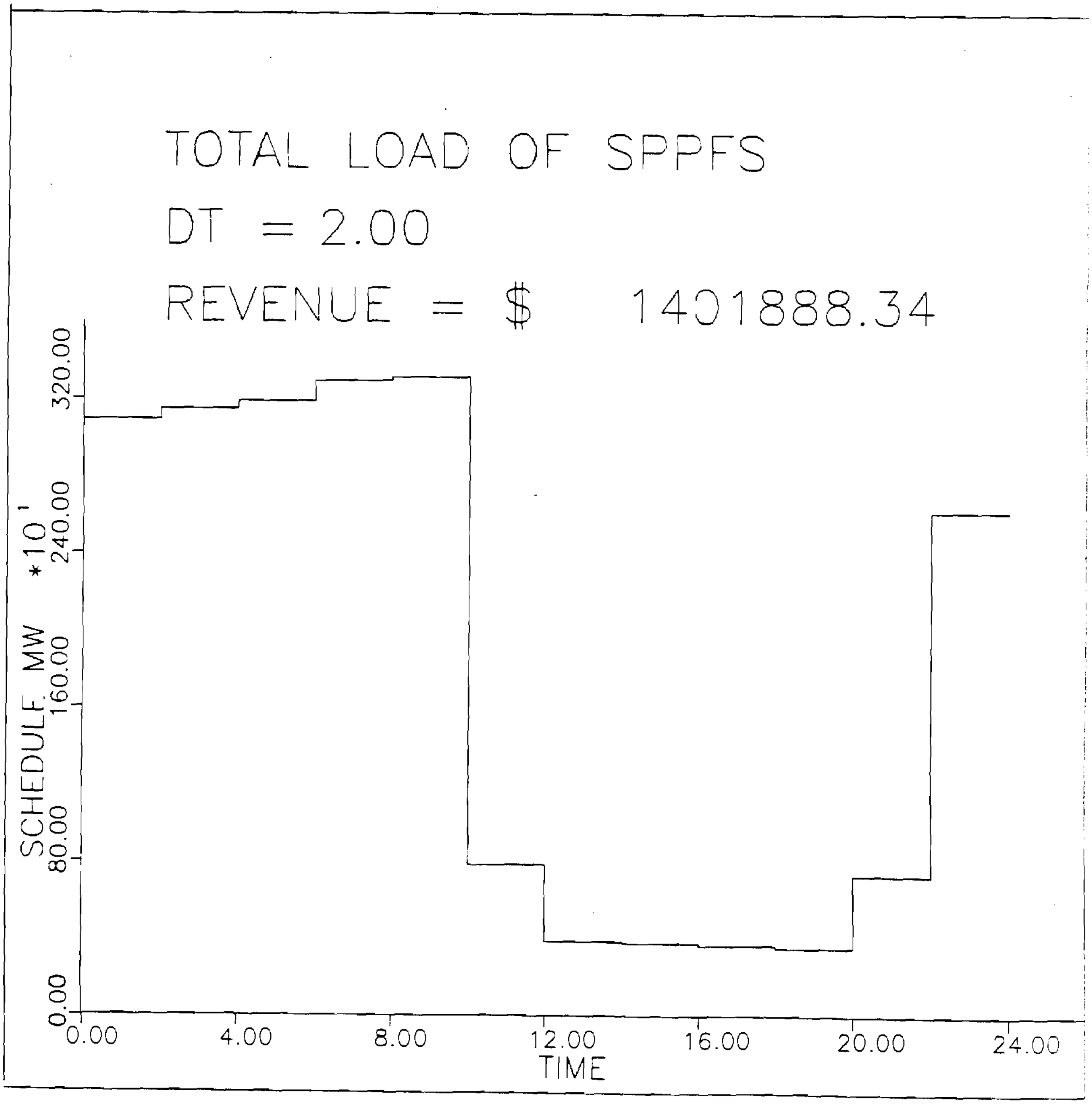
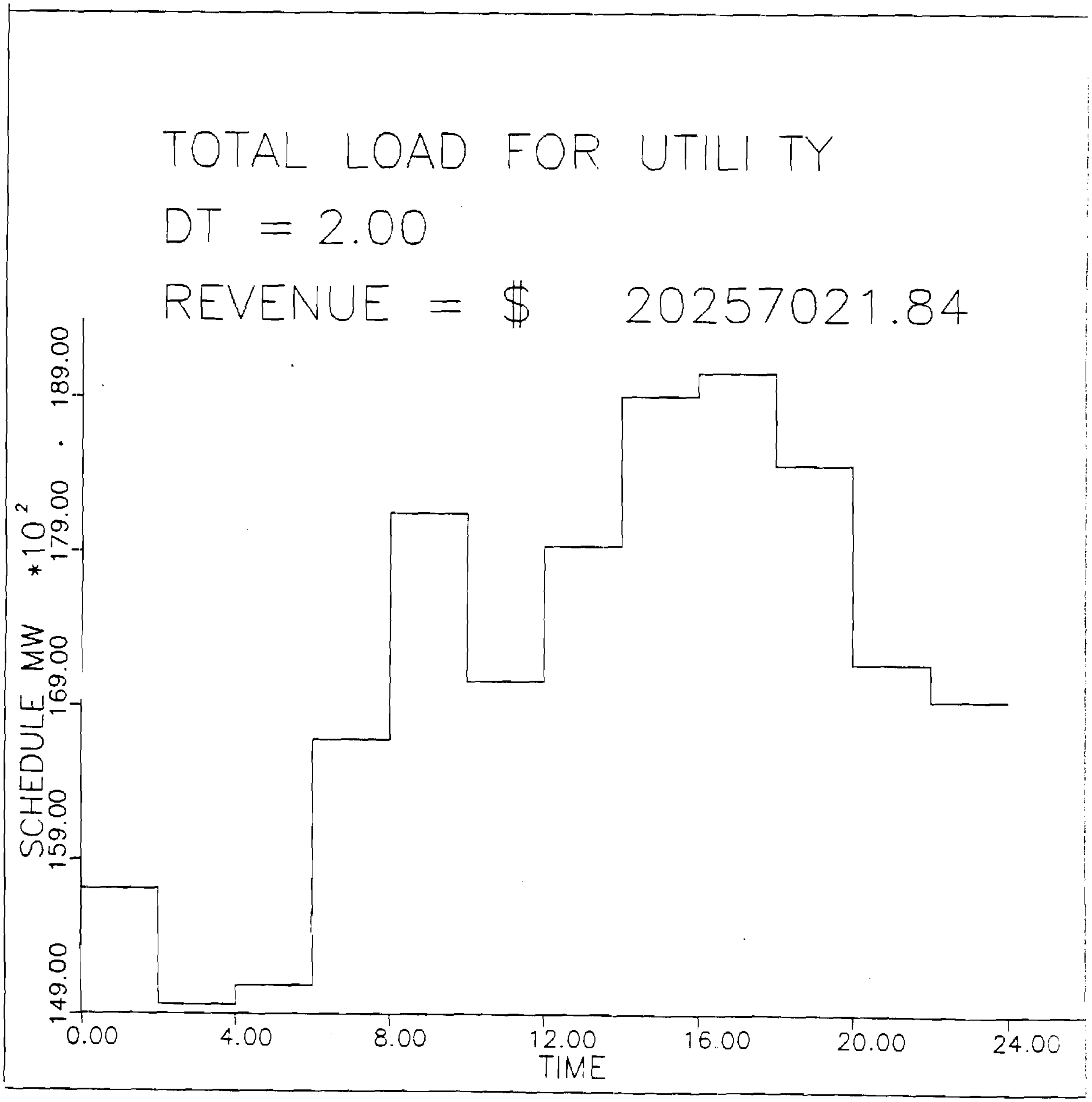


FIGURE 19.

TOTAL UTILITY LOAD CURVE



CHAPTER 8

CONCLUSION

In this project the question of individual optimization of SPPF's was analyzed using various optimization techniques. Four major problems were addressed and solved:

- Optimum scheduling of an individual SPPF.

- Optimum specification of the on-site storage capacity for an SPPF, as an example of other design related paramater optimization.

- Various rate setting problems to get a particular SPPF to display a schedule which fits some predefined utility constraint.

- A system wide impact of a number of SPPF's was also analyzed, various so-called Quality Factors were also computed.

Four computer programs were fully implemented and tested during this project. These programs are fully operational. As an extension to this project, one should seriously consider the extension of these programs to handle a greater number of time intervals during any optimization period to allow for executions over longer time spans. The primary implication here is that of sparsity coding in the Linear Programming optimization itself. Also, the programs could be made more user-friendly before they are released to a wide user group.

As a final comment on this project, it is felt that the next logical major step in this research would be to integrate the models arrived at during this project with a so-called Corporate Model to allow for the global analysis of the SPPF's on the utilities overall revenue situation.

APPENDICES 1, 2, 3

MATHEMATICAL PERFORMANCE INDEX AND CONSTRAINT FORMULATIONS

APPENDIX–1

$$\text{Maximize} \sum_{k=1}^{N} \left[p_k(Y_{3k}+Y_{7k}) - q_k(Y_{1k}+Y_{5k}) - r_k(Y_{2k}+(1/\gamma)Y_{3k}+Y_{4k}) \right] + \rho U_T$$

Subject to:

i) $\varepsilon\, Y_{1k} + \varepsilon\, Y_{2k} \leq R_1(\Delta T) \qquad k=1,2,\ldots,N$

ii) $Y_{2k} + (1/\gamma)\, Y_{3k} + Y_{4k} \leq G_k \qquad k=1,2,\ldots,N$

iii) $Y_{4k} + \gamma\, Y_{5k} + Y_{6k} = U_k \qquad k=1,2,\ldots,N$

iv) $(1/\delta)Y_{6k} + (1/\delta)Y_{7k} \leq R_2(\Delta T) \qquad k=1,2,\ldots,N$

v) $\mu^{j-1}X_o + \sum_{k=1}^{j} \mu^{j-k}\left[\varepsilon(Y_{1k}+Y_{2k}) - 1/\delta(Y_{6k}+Y_{7k})\right] \leq S \qquad j=1,2,\ldots,(N-1)$

vi) $\mu^{j-1}X_o + \sum_{k=1}^{j-1} \mu^{j-k}\left[\varepsilon(Y_{1k}+Y_{2k}) - (1/\delta)(Y_{6k}+Y_{7k})\right] - (1/\delta)(Y_{6j}+Y_{7j}) \geq 0 \qquad j=1,2,\ldots,(N-1)$

vii) $\mu^{N-1}X_o + \sum_{k=1}^{N} \mu^{N-k}\left[\varepsilon(Y_{1k}+Y_{2k}) - (1/\delta)(Y_{6k}+Y_{7k})\right] = X_o$

viii) $X_o \leq S$

APPENDIX–2

Maximize $\sum_{k=1}^{N} \left[p_k(Y_{3K}+Y_{7k}+Y_{10k})-q_k(Y_{1k}+Y_{5k})-r_k(Y_{2k}+(1/\gamma)Y_{3k}+Y_{4k})\right]+\rho u_T-N(\Delta T)\sigma S$

Subject to:

i)	$\varepsilon Y_{1k} + \varepsilon Y_{2k} + \varepsilon Y_{9k}$	$\leq R_1(\Delta T)$	k=1,2,...,N
ii)	$Y_{2k} + (1/\gamma) Y_{3k} + Y_{4k}$	$\leq G_k$	k=1,2,...,N
iii)-a	$Y_{4k} + \gamma Y_{5k} + Y_{6k} - U_k$	$= 0$	k=1,2,...,N
iii)-b	$-U_k$	$\leq -U_L$	k=1,2,...,N
iii)-c	U_k	$\leq U_H$	k=1,2,...,N
iii)-d	$-\beta U_k+Y_{9k}+(1/\gamma)Y_{10k}$	≤ 0	k=1,2,...,N
iv)	$(1/\delta)Y_{6k}+(1/\delta)Y_{7k}$	$\leq R_2(\Delta T)$	k=1,2,...,N

v)-a $\mu^{j-1}x_o + \sum_{k=1}^{j} \mu^{j-k}\left[\varepsilon(Y_{1k}+Y_{2k}+Y_{9k})-(1/\delta)(Y_{6k}+Y_{7k})\right] \leq S$ j=1,2,...,(N-1)

vi)-a $\mu^{j-1}x_o + \sum_{k=1}^{j-1} \mu^{j-k-1}\left[\varepsilon(Y_{1k}+Y_{2k}+Y_{9k})-(1/\delta)(Y_{6k}+Y_{7k})\right]-(1/\delta)(Y_{6j}+Y_{7j}) \geq 0$ j=1,2,...,(N-1)

vii)-a $(\mu^{N-1}-1)X_o + \sum_{k=1}^{N-1} \mu^{N-k-1}\left[\varepsilon(Y_{1k}+Y_{2k}+Y_{9k})-(1/\delta)(Y_{6k}+Y_{7k})\right]-(1/\delta)(Y_{6N}+Y_{7N})=0$

viii) $X_o \leq S$

viii)-a $\sum_{k=1}^{N} U_k = U_T$

APPENDIX—3

Minimize $W^{*} = X^{*t} \begin{bmatrix} p \\ q \end{bmatrix}$

Subject to:

$$\begin{bmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \\ A_{31} & A_{32} \end{bmatrix} \begin{bmatrix} p \\ q \end{bmatrix} \geq - \begin{bmatrix} A_{31} \\ A_{32} \\ A_{33} \end{bmatrix} \begin{bmatrix} c \end{bmatrix}$$

$$\begin{bmatrix} p \\ -q \end{bmatrix} \geq \begin{bmatrix} p_L \\ -q_u \end{bmatrix}$$

$$\begin{bmatrix} -I & | & I \end{bmatrix} \begin{bmatrix} p \\ q \end{bmatrix} \geq 0$$

$$\begin{bmatrix} p \\ q \end{bmatrix} \geq 0$$

APPENDIX 4

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APPENDIX 5

PROGRAM TSCH1

LISTING

```
      PROGRAM TSCH1
     + (INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,
     + TAPE1,TAPE2,TAPE7,TAPE9)

      COMMON /BLK1/ PS(24),QS(24),RS(24),GS(24),US(24)
      REAL A(195,193),B(195),C(193),C1(193)
      REAL PSOL(193),DSOL(195),RW(38522),IW(497)
      REAL P(24),Q(24),R(24),G(24),U(24)
      REAL IBUF(512),SCH(24),SCHT(24),NAME(3)

C
C     THIS PROGRAM CONMPUTES AN OPTIMAL SCHEDULE FOR OPERATION OF
C     LOCAL SMALL POWER PRODUCER.
C
C     PROGRAMMER : HASSAN GHOUDJEHBAKLOU
C     DATE       : 3/1/84
C
C     OPTIONS : IOPT=
C                                PRODUCER   UTILITY
C                                ------------------
C     FIXED                      !   1    !    2  !
C                                ------------------
C     SHIFTABLE                  !   3    !    4  !
C                                ------------------
C     COGENERATION               !   5    !    6  !
C                                ------------------
C
C
C
C
C     M1 = NUMBER OF INEQUALITIES
C     M2 = NUMBER OF EQUALITIES
C     24=N
C
C
C     M1=7*N-1
C     M2=N+2
C     M1+M2=8*N+1
C     195=M1+M2+2=8*N+3
C     193=8*N+1
C     38522=(M1+M2+2)*(M1+M2+2)+3*M1+2*M2+4
C     496  =2*M2+3*M1+4
C
C       DIMENSIONS FOR WITH-COGENERATION
C       M1=7*N-1
C       M2=2*N+2
C       M1+M2=9*N+1
C       219=M1+M2+2=9*N+3
C       241=10*N+1
C       48566=(M1+M2+2)*(M1+M2+2)+3*M1+2*M2+4
C       605=2*M2+3*M1+4
C

      ICH1=1
      ICH2=2
      ICHR=5
      ICHW=6
      ICHT=7
```

```
      MD1=24
      MD2=195
      MD3=193

      PRINT (ICHT,2)
    2 FORMAT("1")
    5 FORMAT(A1)
      SPPFC=0
      READ (ICH1,5) IC
      READ (ICH1,*) (SCHT(I),I=1,MD1)
      READ (ICH1,*) DT,N
      IDT=MD1/N
      DO 15 K=1,N
      TEMP=0
      I1=IDT*(K-1)
      DO 16 J=1,IDT
      TEMP=TEMP+SCHT(I1+J)
   16 CONTINUE
      SCHT(K)=TEMP
   15 CONTINUE
    1 READ (ICH1,*) IOPT
      IF (IOPT.EQ.0) GO TO 8
      PRINT (ICHT,6) IOPT,DT,N
    6 FORMAT(5X,"IOPT=",I2,5X,"DT=",F8.2,2X,"N=",I5/)

      IF ((IOPT.EQ.1).OR.(IOPT.EQ.2)) CALL IN1
     + (ICH1,ICHT,R1,R2,S,EPS,DEL,RGAM,RMEU,N,MD1)
      IF ((IOPT.EQ.1).OR.(IOPT.EQ.2)) CALL IN11
     + (ICHT,IOPT,DT,R1,R2,S,EPS,DEL,RGAM,RMEU,N,MD1)
      IF((IOPT.EQ.3).OR.(IOPT.EQ.4)) CALL IN2
     + (ICH1,ICHT,R1,R2,S,EPS,DEL,RGAM,RMEU,N,UT,UL,UH,MD1)
      IF((IOPT.EQ.5).OR.(IOPT.EQ.6)) CALL IN3
     + (ICH1,ICHT,R1,R2,S,BETA,EPS,DEL,RGAM,RMEU,N,P,Q,R,G,UT,UL,UH,MD1)

    8 CONTINUE
      READ (ICH2,*) NO
      READ (ICH2,7) (NAME(I),I=1,3)
      PRINT (ICHW,13) (NAME(I),I=1,3),NO
   13 FORMAT (//"NAME = ",3A10,5X,"ID NO =",I3/)
    7 FORMAT (3A10)
      PRINT (ICHW,9)
    9 FORMAT(9X,"K",4X,"P(K)",6X,"Q(K)",6X,"R(K)",8X,"G(K)",6X,"U(K)")
      DO 11 I=1,MD1
      READ (ICH2,*) K,PS(K),QS(K),RS(K),GS(K),US(K)
   11 CONTINUE
      IDT=MD1/N
      DO 10 K=1,N
      P(K)=0.
      Q(K)=0.
      R(K)=0.
      G(K)=0.
      U(K)=0.
      I1=IDT*(K-1)
      DO 12 J=1,IDT
      P(K)=P(K)+PS(I1+J)
      Q(K)=Q(K)+QS(I1+J)
```

```
            R(K)=R(K)+RS(I1+J)
            G(K)=G(K)+GS(I1+J)
            U(K)=U(K)+US(I1+J)
   12       CONTINUE
            P(K)=P(K)/IDT
            Q(K)=Q(K)/IDT
            R(K)=R(K)/IDT
            PRINT (ICHW,17) K,P(K),Q(K),R(K),G(K),U(K)
   17       FORMAT(5X,I5,3(F8.4,2X),2(F10.2))
   10       CONTINUE
            READ (ICH2,5) IC
            IF (IOPT.EQ.0) GO TO 1

            IF((IOPT.EQ.1).OR.(IOPT.EQ.2)) CALL FRMLP1
          + (R1,R2,S,EPS,DEL,RGAM,RMEU,DT,N,P,Q,R,G,U,MD1,
          + A,B,C,C1,M1,M2,NP,MD2,MD3)
            IF((IOPT.EQ.3).OR.(IOPT.EQ.4)) CALL FRMLP2
          + (R1,R2,S,EPS,DEL,RGAM,RMEU,DT,N,P,Q,R,G,UT,UL,UH,MD1,
          + A,B,C,C1,M1,M2,NP,MD2,MD3)
            IF((IOPT.EQ.5).OR.(IOPT.EQ.6)) CALL FRMLP3
          + (R1,R2,S,BETA,EPS,DEL,RGAM,RMEU,DT,N,P,Q,R,G,UT,UL,UH,MD1,
          + A,B,C,C1,M1,M2,NP,MD2,MD3)

            IF((IOPT.EQ.1).OR.(IOPT.EQ.3).OR.(IOPT.EQ.5)) CALL ZX3LP
          + (A,MD2,B,C,NP,M1,M2,SMAX,PSOL,DSOL,RW,IW,IER)
            IF((IOPT.EQ.2).OR.(IOPT.EQ.4).OR.(IOPT.EQ.6)) CALL ZX3LP
          + (A,MD2,B,C1,NP,M1,M2,SMAX,PSOL,DSOL,RW,IW,IER)

            CALL OUT(ICHT,IOPT,PSOL,N,SMAX,IER,MD3)

            CALL PRSCH
          +(ICHT,IOPT,P,Q,R,U,PSOL,SCH,N,SMAX,BETA,EPS,DEL,RGAM,RMEU,MD1,MD3)

            PRINT (ICHW,22) (SCH(I),I=1,N)
   22       FORMAT (15X,10(F8.2,2X))
            DO 30 I=1,N
            SCHT(I)=SCHT(I)-SCH(I)
   30       CONTINUE
            PRINT (ICHW,23) SMAX
   23       FORMAT (5X,"COST = ",F8.2)
            SPPFC=SPPFC+SMAX
            GO TO 1
   1000     PRINT (ICHW,22) (SCHT(I),I=1,N)
            PRINT (ICHW,24) SPPFC
   24       FORMAT (5X,"SPPF COST = ",F8.2)

  C         READ (ICHR,10) ICOMM1,ICOMM2,ICOMM3
  C10       FORMAT(8A10)
  C         CALL PLOTS(IBUF,512,9,00)
  C         CALL PLTSQ(15.,15.,.5,SMAX,ICOMM1,ICOMM2,ICOMM3)
  C         CALL PLT1(P,1.,7.,DT,N,.5,"TIME","SELL $/KWH",4,10,MD1)
  C         CALL PLT1(Q,7.,0.,DT,N,.5,"TIME","BUY $/KWH",4,9,MD1)
  C         CALL PLT1(U,-7.,-6.,DT,N,.5,"TIME","USE $/KWH",4,9,MD1)
  C         CALL PLT1(SCH,7.,0.,DT,N,.5,"TIME","SCHEDULE KWH",4,12,MD1)
  C         CALL PLOT(0.,0.,999)
            STOP
            END
```

```
      SYMBOLIC REFERENCE MAP (R=1)

 ENTRY POINTS
 14426   TSCH1

 VARIABLES      SN  TYPE           RELOCATION
  15476  A          REAL        ARRAY                    127101  B          REAL       ARRAY
  15467  BETA       REAL                                 127404  C          REAL       ARRAY
 127705  C1         REAL        ARRAY                     15461  DEL        REAL
 130507  DSOL       REAL        ARRAY                     15445  DT         REAL
  15460  EPS        REAL                                 245275  G          REAL       ARRAY
    110  GS         REAL        ARRAY     BLK1            15444  I          INTEGER
 245355  IBUF       REAL       *UNDEF                     15443  IC         INTEGER
  15434  ICHR       INTEGER                               15436  ICHT       INTEGER
  15435  ICHW       INTEGER                               15432  ICH1       INTEGER
  15433  ICH2       INTEGER                               15447  IDT        INTEGER
  15475  IER        INTEGER                               15454  IOPT       INTEGER
 244204  IW         REAL        ARRAY                     15452  I1         INTEGER
  15453  J          INTEGER                               15450  K          INTEGER
  15437  MD1        INTEGER                               15440  MD2        INTEGER
  15441  MD3        INTEGER                               15471  M1         INTEGER
  15472  M2         INTEGER                               15446  N          INTEGER
 246435  NAME       REAL        ARRAY                     15470  NO         INTEGER
  15473  NP         INTEGER                              245165  P          REAL       ARRAY
      0  PS         REAL        ARRAY     BLK1           130206  PSOL       REAL       ARRAY
 245215  Q          REAL        ARRAY                        30  QS         REAL       ARRAY     BLK1
 245245  R          REAL        ARRAY                     15462  RGAM       REAL
  15463  RMEU       REAL                                     60  RS         REAL       ARRAY     BLK1
 131012  RW         REAL        ARRAY                     15455  R1         REAL
  15456  R2         REAL                                  15457  S          REAL
 246355  SCH        REAL        ARRAY                    246405  SCHT       REAL       ARRAY
  15474  SMAX       REAL                                  15442  SPPFC      REAL
  15451  TEMP       REAL                                 245325  U          REAL       ARRAY
  15466  UH         REAL                                  15465  UL         REAL
    140  US         REAL        ARRAY     BLK1            15464  UT         REAL

 FILE NAMES         MODE
      0  INPUT                    2054  OUTPUT                    4130  TAPE1                  62
      0  TAPE5                    2054  TAPE6                    10260  TAPE7                 123

 EXTERNALS          TYPE   ARGS
         FRMLP1             24                                   FRMLP2              26
         FRMLP3             27                                   IN1                 11
         IN11               12                                   IN2                 14
         IN3                19                                   OUT                  7
         PRSCH              17                                   ZX3LP               13

 STATEMENT LABELS
  14477  1                             15242  2      FMT                       15244  5
  15276  6      FMT                    15327  7      FMT                       14534  8
  15334  9      FMT                        0  10                                   0  11
      0  12                            15322  13     FMT                           0  15
      0  16                            15366  17     FMT                       15403  22
  15412  23     FMT                    15425  24     FMT                           0  30
      0  1000       INACTIVE
```

```
LOOPS  LABEL    INDEX     FROM-TO    LENGTH   PROPERTIES
14457  15       K           71  78      20B                 NOT INNER
14467  16       J           74  76       3B        OPT
14545  11       I          101 103      16B                 EXT REFS
14567  10       K          105 124      50B                 EXT REFS  NOT INNER
14602  12       J          112 118      13B        OPT
14715  30       I          150 152       3B        OPT

COMMON BLOCKS   LENGTH
       BLK1        120

STATISTICS
  PROGRAM LENGTH               232537B   79199
  BUFFER LENGTH                 13701B    6081
  CM LABELED COMMON LENGTH        170B     120
         52000B CM USED
```

```
                SUBROUTINE IN1
     +          (ICHR,ICHT,R1,R2,S,EPS,DEL,RGAM,RMEU,N,MD1)


C
C               THIS ROUTINE READS THE INPUT FILE AND PRINTS OUT A COPY OF THEM.
C

                READ (ICHR,5) IC
    5           FORMAT(A1)
                READ (ICHR,*) R1,R2,S,EPS,DEL
                PRINT (ICHT,7) R1,R2,S,EPS,DEL
    7           FORMAT(5X,"R1=",F8.2,2X,"R2=",F8.2,2X,"S=",F8.2,2X,
     +          "EPS=",F5.3,5X,"DEL=",F5.3,5X)
                READ (ICHR,5) IC
                READ (ICHR,*) RGAM,RMEU
                PRINT (ICHT,8) RGAM,RMEU
    8           FORMAT(5X,"GAMMA=",F5.3,5X,"MEU=",F5.3/)
                READ (ICHR,5) IC
                RETURN
                END
```

```
      SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3   IN1

VARIABLES       SN  TYPE             RELOCATION
    0  DEL          REAL                  F.P.           0  EPS       REAL                    F.P.
  115  IC           INTEGER                              0  ICHR      INTEGER                 F.P.
    0  ICHT         INTEGER               F.P.           0  MD1       INTEGER    *UNUSED      F.P.
    0  N            INTEGER    *UNUSED    F.P.           0  RGAM      REAL                    F.P.
    0  RMEU         REAL                  F.P.           0  R1        REAL                    F.P.
    0  R2           REAL                  F.P.           0  S         REAL                    F.P.

STATEMENT LABELS
   31  5       FMT                     53  7       FMT                     103  8

STATISTICS
  PROGRAM LENGTH               116B        78
          52000B CM USED
```

```
                 SUBROUTINE IN2
               + (ICHR,ICHT,R1,R2,S,EPS,DEL,RGAM,RMEU,N,UT,UL,UH,MD1)


          C
          C      THIS ROUTINE READS THE INPUT FILE AND PRINTS OUT A COPY OF THEM.
          C

                 READ (ICHR,5) IC
           5     FORMAT(A1)
                 READ (ICHR,*) R1,R2,S,EPS,DEL
                 PRINT (ICHT,7) R1,R2,S,EPS,DEL
           7     FORMAT(5X,"R1=",F8.2,2X,"R2=",F8.2,2X,"S=",F8.2,2X,
               + "EPS=",F5.3,5X,"DEL=",F5.3,5X)
                 READ (ICHR,5) IC
                 READ (ICHR,*) RGAM,RMEU
                 PRINT (ICHT,6) RGAM,RMEU
           6     FORMAT(5X,"GAMMA=",F5.3,5X,"MEU=",F5.3/)
                 READ (ICHR,5) IC
                 READ (ICHR,*) UT,UL,UH
                 PRINT (ICHT,8) UT,UL,UH
           8     FORMAT(5X,"UT=",F8.2,2X,"UL=",F8.2,2X,"UH=",F8.2//)
                 READ (ICHR,5) IC
                 RETURN
                 END
```

```
     SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  IN2

VARIABLES       SN  TYPE           RELOCATION
    0  DEL          REAL                    F.P.          0  EPS     REAL                 F.P.
  152  IC           INTEGER                               0  ICHR    INTEGER              F.P.
    0  ICHT         INTEGER                 F.P.          0  MD1     INTEGER   *UNUSED    F.P.
    0  N            INTEGER    *UNUSED      F.P.          0  RGAM    REAL                 F.P.
    0  RMEU         REAL                    F.P.          0  R1      REAL                 F.P.
    0  R2           REAL                    F.P.          0  S       REAL                 F.P.
    0  UH           REAL                    F.P.          0  UL      REAL                 F.P.
    0  UT           REAL                    F.P.

STATEMENT LABELS
   37  5       FMT                  111  6       FMT                     61  7
  137  8       FMT

STATISTICS
  PROGRAM LENGTH               153B      107
          52000B CM USED
```

```
      SUBROUTINE IN3
     + (ICHR,ICHT,R1,R2,S,BETA,EPS,DEL,RGAM,RMEU,N,UT,UL,UH,MD1)


C
C     THIS ROUTINE READS THE INPUT FILE AND PRINTS OUT A COPY OF THEM.
C

      READ (ICHR,5) IC
 5    FORMAT(A1)
      READ (ICHR,*) R1,R2,S,EPS,DEL
      PRINT (ICHT,7) R1,R2,S,EPS,DEL
 7    FORMAT(5X,"R1=",F8.2,2X,"R2=",F8.2,2X,"S=",F8.2,2X,
     + "EPS=",F5.3,5X,"DEL=",F5.3)
      READ (ICHR,5) IC
      READ (ICHR,*) BETA,RGAM,RMEU
      PRINT (ICHT,6) BETA,RGAM,RMEU
 6    FORMAT(5X,"BETA=",F5.3,5X,"GAMMA=",F5.3,5X,"MEU=",F5.3/)
      READ (ICHR,5) IC
      READ (ICHR,*) UT,UL,UH
      PRINT (ICHT,8) UT,UL,UH
 8    FORMAT(5X,"UT=",F8.2,2X,"UL=",F8.2,2X,"UH=",F8.2//)
      READ (ICHR,5) IC
      RETURN
      END
```

```
      SYMBOLIC REFERENCE MAP  (R=1)

ENTRY POINTS
    3  IN3

VARIABLES      SN  TYPE              RELOCATION
    0  BETA       REAL                    F.P.           0  DEL        REAL                     F.P.
    0  EPS        REAL                    F.P.         155  IC         INTEGER
    0  ICHR       INTEGER                 F.P.           0  ICHT       INTEGER                  F.P.
    0  MD1        INTEGER    *UNUSED      F.P.           0  N          INTEGER   *UNUSED        F.P.
    0  RGAM       REAL                    F.P.           0  RMEU       REAL                     F.P.
    0  R1         REAL                    F.P.           0  R2         REAL                     F.P.
    0  S          REAL                    F.P.           0  UH         REAL                     F.P.
    0  UL         REAL                    F.P.           0  UT         REAL                     F.P.

STATEMENT LABELS
   37  5       FMT                      113  6        FMT                         61  7
  142  8       FMT

STATISTICS
  PROGRAM LENGTH                 156B       110
         52000B CM USED
```

```
      SUBROUTINE FRMLP1(R1,R2,S,EPS,DEL,RGAM,RMEU,DT,N,P,Q,R,G,U,MD1,
     + A,B,C,C1,M1,M2,NP,MD2,MD3)

      REAL P(MD1),Q(MD1),R(MD1),G(MD1),U(MD1)
      REAL A(MD2,MD3),B(MD2),C(MD3),C1(MD3)

C
C     THIS ROUTINE FORMS THE OPERATING MATRICES FOR THE LINEAR
C     PROGRAMMING EXECUTION.
C

      M1=5*N-1
      M2=N+1
      NP=7*N+1

C     CLEAR A,B,C
      M3=M1+M2+2
      DO 2 I=1,M3
      B(I)=0
      DO 2 J=1,NP
      A(I,J)=0
    2 CONTINUE
      DO 3 J=1,NP
      C(J)=0
      C1(J)=0
    3 CONTINUE

C     M1 INEQUALITY CONSTRAINTS
      A(1,1)=1
      B(1)=S
      DO 30 K=1,N
      I1=3*(K-1)+1
      I2=7*(K-1)+1
      A(I1+1,I2+1)=EPS
      A(I1+1,I2+2)=EPS
      B(I1+1)=R1*DT

      A(I1+2,I2+2)=1
      A(I1+2,I2+3)=1.0/RGAM
      A(I1+2,I2+4)=1
      B(I1+2)=G(K)

      A(I1+3,I2+6)=1.0/DEL
      A(I1+3,I2+7)=1.0/DEL
      B(I1+3)=R2*DT
   30 CONTINUE

      TMEU1=1.0/RMEU
      N1=N-1
      DO 40 J=1,N1
      TMEU2=1.0/RMEU
      TMEU1=TMEU1*RMEU
      J1=2*(J-1)
      A(I1+J1+4,1)=TMEU1
      A(I1+J1+5,1)=-TMEU1
      B(I1+J1+4)=S
      B(I1+J1+5)=0
```

```
      DO 50 K1=1,J
      TMEU2=TMEU2*RMEU
      K=J-K1+1
      K2=7*(K-1)+1
      A(I1+J1+4,K2+1)=EPS*TMEU2
      IF (K.NE.J) A(I1+J1+5,K2+1)=-EPS*TMEU2
      A(I1+J1+4,K2+2)=EPS*TMEU2
      IF (K.NE.J) A(I1+J1+5,K2+2)=-EPS*TMEU2
      A(I1+J1+4,K2+6)=-TMEU2/DEL
      A(I1+J1+5,K2+6)=TMEU2/DEL
      A(I1+J1+4,K2+7)=-TMEU2/DEL
      A(I1+J1+5,K2+7)=TMEU2/DEL
   50 CONTINUE
   40 CONTINUE

C     M2 EQUALITY CONSTRAINTS

      DO 60 K=1,N
      I2=7*(K-1)+1
      A(M1+K,I2+4)=1
      A(M1+K,I2+5)=RGAM
      A(M1+K,I2+6)=1
      B(M1+K)=U(K)
   60 CONTINUE

      A(M1+N+1,1)=TMEU2*RMEU-1.0
      C(1)=-1.0E-8
      TMEU1=1.0/RMEU
      DO 70 K1=1,N
      TMEU1=TMEU1*RMEU
      K=N-K1+1
      I2=7*(K-1)+1
      A(M1+N+1,I2+1)=EPS*TMEU1
      A(M1+N+1,I2+2)=EPS*TMEU1
      A(M1+N+1,I2+6)=-TMEU1/DEL
      A(M1+N+1,I2+7)=-TMEU1/DEL
      C(I2+1)=-Q(K)
      C(I2+2)=-R(K)
      C(I2+3)=P(K)-R(K)/RGAM
      C(I2+4)=-R(K)
      C(I2+5)=-Q(K)
      C(I2+7)=P(K)

      C1(I2+1)=Q(K)
      C1(I2+3)=-P(K)
      C1(I2+5)=Q(K)
      C1(I2+7)=-P(K)

   70 CONTINUE
      B(M1+N+1)=0
      RETURN
      END
```

```
      SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  FRMLP1

VARIABLES       SN  TYPE           RELOCATION
    0  A            REAL       ARRAY     F.P.              0  B         REAL       ARRAY      F.P.
    0  C            REAL       ARRAY     F.P.              0  C1        REAL       ARRAY      F.P.
    0  DEL          REAL                 F.P.              0  DT        REAL                  F.P.
    0  EPS          REAL                 F.P.              0  G         REAL       ARRAY      F.P.
  352  I            INTEGER                              355  I1        INTEGER
  356  I2           INTEGER                              353  J         INTEGER
  362  J1           INTEGER                              354  K         INTEGER
  363  K1           INTEGER                              364  K2        INTEGER
    0  MD1          INTEGER              F.P.              0  MD2       INTEGER               F.P.
    0  MD3          INTEGER              F.P.              0  M1        INTEGER               F.P.
    0  M2           INTEGER              F.P.            351  M3        INTEGER
    0  N            INTEGER              F.P.              0  NP        INTEGER               F.P.
  360  N1           INTEGER                                0  P         REAL       ARRAY      F.P.
    0  Q            REAL       ARRAY     F.P.              0  R         REAL       ARRAY      F.P.
    0  RGAM         REAL                 F.P.              0  RMEU      REAL                  F.P.
    0  R1           REAL                 F.P.              0  R2        REAL                  F.P.
    0  S            REAL                 F.P.            357  TMEU1     REAL
  361  TMEU2        REAL                                   0  U         REAL       ARRAY      F.P.

STATEMENT LABELS
    0  2                                    0  3                                      0  30
    0  40                                   0  50                                     0  60
    0  70

LOOPS  LABEL    INDEX    FROM-TO    LENGTH    PROPERTIES
   21  2        I          18 22       15B                NOT INNER
   30  2        J          20 22        2B        OPT
   43  3        J          23 26        2B        OPT
  107  30       K          31 46       22B        OPT
  137  40       J          50 71       61B                NOT INNER
  164  50       K1         58 70       30B        OPT
  241  60       K          75 81        7B        OPT
  300  70       K1         86 106      26B        OPT

STATISTICS
  PROGRAM LENGTH                427B      279
        52000B CM USED
```

```
      SUBROUTINE FRMLP2
     + (R1,R2,S,EPS,DEL,RGAM,RMEU,DT,N,P,Q,R,G,UT,UL,UH,MD1,
     + A,B,C,C1,M1,M2,NP,MD2,MD3)

      REAL P(MD1),Q(MD1),R(MD1),G(MD1)
      REAL A(MD2,MD3),B(MD2),C(MD3),C1(MD3)

C
C     THIS ROUTINE FORMS THE OPERATING MATRICES FOR THE LINEAR
C     PROGRAMMING EXECUTION.
C

      M1=7*N-1
      M2=N+2
      NP=8*N+1

C     CLEAR A,B,C
      M3=M1+M2+2
      DO 2 I=1,M3
      B(I)=0
      DO 2 J=1,NP
      A(I,J)=0
 2    CONTINUE
      DO 3 J=1,NP
      C(J)=0
      C1(J)=0
 3    CONTINUE

C     M1 INEQUALITY CONSTRAINTS
      A(1,1)=1
      B(1)=S
      DO 30 K=1,N
      I1=5*(K-1)+1
      I2=8*(K-1)+1
      A(I1+1,I2+1)=EPS
      A(I1+1,I2+2)=EPS
      B(I1+1)=R1*DT

      A(I1+2,I2+2)=1
      A(I1+2,I2+3)=1.0/RGAM
      A(I1+2,I2+4)=1
      B(I1+2)=G(K)

      A(I1+3,I2+6)=1.0/DEL
      A(I1+3,I2+7)=1.0/DEL
      B(I1+3)=R2*DT

      A(I1+4,I2+8)=1
      B(I1+4)=UH

      A(I1+5,I2+8)=-1
      B(I1+5)=-UL
 30   CONTINUE
      M4=5*N+1

      TMEU1=1.0/RMEU
      N1=N-1
```

```
      DO 40 J=1,N1
      TMEU2=1.0/RMEU
      TMEU1=TMEU1*RMEU
      J1=2*(J-1)
      A(M4+J1+1,1)=TMEU1
      A(M4+J1+2,1)=-TMEU1
      B(M4+J1+1)=S
      B(M4+J1+2)=0
      DO 50 K1=1,J
      TMEU2=TMEU2*RMEU
      K=J-K1+1
      K2=8*(K-1)+1
      A(M4+J1+1,K2+1)=EPS*TMEU2
      IF(K.NE.J) A(M4+J1+2,K2+1)=-EPS*TMEU2
      A(M4+J1+1,K2+2)=EPS*TMEU2
      IF(K.NE.J) A(M4+J1+2,K2+2)=-EPS*TMEU2
      A(M4+J1+1,K2+6)=-TMEU2/DEL
      A(M4+J1+2,K2+6)=TMEU2/DEL
      A(M4+J1+1,K2+7)=-TMEU2/DEL
      A(M4+J1+2,K2+7)=TMEU2/DEL
   50 CONTINUE
   40 CONTINUE

C     M2 EQUALITY CONSTRAINTS

      DO 60 K=1,N
      I2=8*(K-1)+1
      A(M1+K,I2+4)=1
      A(M1+K,I2+5)=RGAM
      A(M1+K,I2+6)=1
      A(M1+K,I2+8)=-1
   60 CONTINUE

      A(M1+N+1,1)=TMEU2*RMEU-1.0
      C(1)=-1.0E-8
      TMEU1=1.0/RMEU
      DO 70 K1=1,N
      TMEU1=TMEU1*RMEU
      K=N-K1+1
      I2=8*(K-1)+1
      A(M1+N+1,I2+1)=EPS*TMEU1
      A(M1+N+1,I2+2)=EPS*TMEU1
      A(M1+N+1,I2+6)=-TMEU1/DEL
      A(M1+N+1,I2+7)=-TMEU1/DEL
      A(M1+N+2,I2+8)=1

      C(I2+1)=-Q(K)
      C(I2+2)=-R(K)
      C(I2+3)=P(K)-R(K)/RGAM
      C(I2+4)=-R(K)
      C(I2+5)=-Q(K)
      C(I2+7)=P(K)

      C1(I2+1)=Q(K)
      C1(I2+3)=-P(K)
      C1(I2+5)=Q(K)
      C1(I2+7)=-P(K)
```

```
   70   CONTINUE
        B(M1+N+1)=0
        B(M1+N+2)=UT
        RETURN
        END
```

SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
0 FRMLP2

VARIABLES		SN TYPE		RELOCATION					
0	A	REAL	ARRAY	F.P.	0	B	REAL	ARRAY	F.P.
0	C	REAL	ARRAY	F.P.	0	C1	REAL	ARRAY	F.P.
0	DEL	REAL		F.P.	0	DT	REAL		F.P.
0	EPS	REAL		F.P.	0	G	REAL	ARRAY	F.P.
400	I	INTEGER			403	I1	INTEGER		
404	I2	INTEGER			401	J	INTEGER		
411	J1	INTEGER			402	K	INTEGER		
412	K1	INTEGER			413	K2	INTEGER		
0	MD1	INTEGER		F.P.	0	MD2	INTEGER		F.P.
0	MD3	INTEGER		F.P.	0	M1	INTEGER		F.P.
0	M2	INTEGER		F.P.	377	M3	INTEGER		
405	M4	INTEGER			0	N	INTEGER		F.P.
0	NP	INTEGER		F.P.	407	N1	INTEGER		
0	P	REAL	ARRAY	F.P.	0	Q	REAL	ARRAY	F.P.
0	R	REAL	ARRAY	F.P.	0	RGAM	REAL		F.P.
0	RMEU	REAL		F.P.	0	R1	REAL		F.P.
0	R2	REAL		F.P.	0	S	REAL		F.P.
406	TMEU1	REAL			410	TMEU2	REAL		
0	UH	REAL		F.P.	0	UL	REAL		F.P.
0	UT	REAL		F.P.					

STATEMENT LABELS

0	2	0	3	0	30
0	40	0	50	0	60
0	70				

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
20	2	I	19 23	15B	NOT INNER
27	2	J	21 23	2B	OPT
42	3	J	24 27	2B	OPT
113	30	K	32 53	27B	OPT
151	40	J	58 79	61B	NOT INNER
176	50	K1	66 78	30B	OPT
255	60	K	83 89	7B	OPT
320	70	K1	94 116	30B	OPT

STATISTICS
PROGRAM LENGTH 457B 303
52000B CM USED

```
      SUBROUTINE FRMLP3
     + (R1,R2,S,BETA,EPS,DEL,RGAM,RMEU,DT,N,P,Q,R,G,UT,UL,UH,MD1,
     + A,B,C,C1,M1,M2,NP,MD2,MD3)

      REAL P(MD1),Q(MD1),R(MD1),G(MD1)
      REAL A(MD2,MD3),B(MD2),C(MD3),C1(MD3)

C
C     THIS ROUTINE FORMS THE OPERATING MATRICES FOR THE LINEAR
C     PROGRAMMING EXECUTION.
C

      M1=7*N-1
      M2=2*N+2
      NP=10*N+1

C     CLEAR A,B,C
      M3=M1+M2+2
      DO 2 I=1,M3
      B(I)=0
      DO 2 J=1,NP
      A(I,J)=0
    2 CONTINUE
      DO 3 J=1,NP
      C(J)=0
      C1(J)=0
    3 CONTINUE

C     M1 INEQUALITY CONSTRAINTS
      A(1,1)=1
      B(1)=S
      DO 30 K=1,N
      I1=5*(K-1)+1
      I2=10*(K-1)+1
      A(I1+1,I2+1)=EPS
      A(I1+1,I2+2)=EPS
      A(I1+1,I2+9)=EPS
      B(I1+1)=R1*DT

      A(I1+2,I2+2)=1
      A(I1+2,I2+3)=1.0/RGAM
      A(I1+2,I2+4)=1
      B(I1+2)=G(K)

      A(I1+3,I2+6)=1.0/DEL
      A(I1+3,I2+7)=1.0/DEL
      B(I1+3)=R2*DT

      A(I1+4,I2+8)=1
      B(I1+4)=UH

      A(I1+5,I2+8)=-1
      B(I1+5)=-UL
   30 CONTINUE
      M4=5*N+1

      TMEU1=1.0/RMEU
```

```
      N1=N-1
      DO 40 J=1,N1
      TMEU2=1.0/RMEU
      TMEU1=TMEU1*RMEU
      J1=2*(J-1)
      A(M4+J1+1,1)=TMEU1
      A(M4+J1+2,1)=-TMEU1
      B(M4+J1+1)=S
      B(M4+J1+2)=0
      DO 50 K1=1,J
      TMEU2=TMEU2*RMEU
      K=J-K1+1
      K2=10*(K-1)+1
      A(M4+J1+1,K2+1)=EPS*TMEU2
      IF(K.NE.J)  A(M4+J1+2,K2+1)=-EPS*TMEU2
      A(M4+J1+1,K2+2)=EPS*TMEU2
      IF(K.NE.J)  A(M4+J1+2,K2+2)=-EPS*TMEU2
      A(M4+J1+1,K2+9)=EPS*TMEU2
      IF(K.NE.J)  A(M4+J1+2,K2+9)=-EPS*TMEU2
      A(M4+J1+1,K2+6)=-TMEU2/DEL
      A(M4+J1+2,K2+6)=TMEU2/DEL
      A(M4+J1+1,K2+7)=-TMEU2/DEL
      A(M4+J1+2,K2+7)=TMEU2/DEL
   50 CONTINUE
   40 CONTINUE

C     M2 EQUALITY CONSTRAINTS

      DO 60 K=1,N
      I2=10*(K-1)+1
      A(M1+K,I2+4)=1
      A(M1+K,I2+5)=RGAM
      A(M1+K,I2+6)=1
      A(M1+K,I2+8)=-1
      A(M1+N+K,I2+9)=1
      A(M1+N+K,I2+10)=1.0/RGAM
      A(M1+N+K,I2+8)=-BETA
   60 CONTINUE

      A(M1+2*N+1,1)=TMEU2*RMEU-1.0
      C(1)=-1.0E-8
      TMEU1=1.0/RMEU
      DO 70 K1=1,N
      TMEU1=TMEU1*RMEU
      K=N-K1+1
      I2=10*(K-1)+1
      A(M1+2*N+1,I2+1)=EPS*TMEU1
      A(M1+2*N+1,I2+2)=EPS*TMEU1
      A(M1+2*N+1,I2+9)=EPS*TMEU1
      A(M1+2*N+1,I2+6)=-TMEU1/DEL
      A(M1+2*N+1,I2+7)=-TMEU1/DEL
      A(M1+2*N+2,I2+8)=1

      C(I2+1)=-Q(K)
      C(I2+2)=-R(K)
      C(I2+3)=P(K)-R(K)/RGAM
      C(I2+4)=-R(K)
```

```
                   C(I2+5)=-Q(K)
                   C(I2+7)=P(K)
                   C(I2+10)=P(K)

                   C1(I2+1)=Q(K)
                   C1(I2+3)=-P(K)
                   C1(I2+5)=Q(K)
                   C1(I2+7)=-P(K)
                   C1(I2+10)=-P(K)

             70    CONTINUE
                   B(M1+2*N+2)=UT
                   RETURN
                   END
```

```
    SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  FRMLP3

VARIABLES      SN  TYPE          RELOCATION
    0  A           REAL       ARRAY     F.P.          0  B       REAL      ARRAY    F.P.
    0  BETA        REAL                 F.P.          0  C       REAL      ARRAY    F.P.
    0  C1          REAL       ARRAY     F.P.          0  DEL     REAL               F.P.
    0  DT          REAL                 F.P.          0  EPS     REAL               F.P.
    0  G           REAL       ARRAY     F.P.        464  I       INTEGER
  467  I1          INTEGER                          470  I2      INTEGER
  465  J           INTEGER                          475  J1      INTEGER
  466  K           INTEGER                          476  K1      INTEGER
  477  K2          INTEGER                            0  MD1     INTEGER            F.P.
    0  MD2         INTEGER              F.P.          0  MD3     INTEGER            F.P.
    0  M1          INTEGER              F.P.          0  M2      INTEGER            F.P.
  463  M3          INTEGER                          471  M4      INTEGER
    0  N           INTEGER              F.P.          0  NP      INTEGER            F.P.
  473  N1          INTEGER                            0  P       REAL      ARRAY    F.P.
    0  Q           REAL       ARRAY     F.P.          0  R       REAL      ARRAY    F.P.
    0  RGAM        REAL                 F.P.          0  RMEU    REAL               F.P.
    0  R1          REAL                 F.P.          0  R2      REAL               F.P.
    0  S           REAL                 F.P.        472  TMEU1   REAL
  474  TMEU2       REAL                               0  UH      REAL               F.P.
    0  UL          REAL                 F.P.          0  UT      REAL               F.P.

STATEMENT LABELS
    0  2                               0  3                                  0  30
    0  40                              0  50                                 0  60
    0  70

LOOPS  LABEL    INDEX     FROM-TO    LENGTH   PROPERTIES
   21  2        I          19 23       15B                NOT INNER
   30  2        J          21 23        2B       OPT
   43  3        J          24 27        2B       OPT
  116  30       K          32 54       32B       OPT
  157  40       J          59 82       73B                NOT INNER
```

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
206	50	K1	67 81	40B	OPT
320	60	K	86 95	16B	OPT
377	70	K1	100 125	33B	OPT

STATISTICS
PROGRAM LENGTH 552B 362
52000B CM USED

```
                  SUBROUTINE OUT(ICHT,IOPT,PSOL,N,SMAX,IER,MD3)
                  REAL PSOL(MD3)
      C
      C           THIS ROUTINE OUTPUTS THE RESULTS OF THE OPTIMUM SPOT PRICING
      C           PROCEDURE.
      C
                  IF((IOPT.EQ.1).OR.(IOPT.EQ.2)) ISOE=7
                  IF((IOPT.EQ.3).OR.(IOPT.EQ.4)) ISOE=8
                  IF((IOPT.EQ.5).OR.(IOPT.EQ.6)) ISOE=10
                  PRINT (ICHT,5)
             5    FORMAT("1")
                  PRINT (ICHT,7) PSOL(1),SMAX,IER
             7    FORMAT(10X,"X0=",F8.2,8X,"REVENUE=",F10.2,8X,"ERROR=",I5/)
                  PRINT (ICHT,12) (I,I=1,ISOE)
            12    FORMAT(8X,"   K     ",10(I5,5X))
                  PRINT (ICHT,14)
            14    FORMAT(4X,"PERIOD")
                  DO 10 K=1,N
                  I2=ISOE*(K-1)+1
                  PRINT (ICHT,15) K,(PSOL(I2+I),I=1,ISOE)
            15    FORMAT(7X,I3,5X,10(F8.2,2X))
            10    CONTINUE
                  RETURN
                  END
```

```
      SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  OUT

VARIABLES       SN  TYPE          RELOCATION
  147  I            INTEGER                                0  ICHT      INTEGER                F.P.
    0  IER          INTEGER             F.P.               0  IOPT      INTEGER                F.P.
  146  ISOE         INTEGER                              151  I2        INTEGER
  150  K            INTEGER                                0  MD3       INTEGER                F.P.
    0  N            INTEGER             F.P.               0  PSOL      REAL          ARRAY    F.P.
    0  SMAX         REAL                F.P.

STATEMENT LABELS
   75  5        FMT                         105  7        FMT                        0  10
  122  12       FMT                         131  14       FMT                      143  15

LOOPS  LABEL    INDEX    FROM-TO    LENGTH    PROPERTIES
   37           I         17 17       4B                EXT REFS
   47  10       K         21 25      22B                EXT REFS  NOT INNER
   55           I         23 23      10B                EXT REFS

STATISTICS
  PROGRAM LENGTH               155B      109
      52000B CM USED
```

```
      SUBROUTINE PRSCH
     +(ICHT,IOPT,P,Q,R,U,PSOL,SCH,N,SMAX,BETA,EPS,DEL,RGAM,RMEU,MD1,MD3)

      REAL P(MD1),Q(MD1),R(MD1),U(MD1),PSOL(MD3)
      REAL SCH(MD1)

C
C     THIS ROUTINE PRINTS OUT THE OPTIMAL OPERATING SCHEDULE
C

      PRINT (ICHT,5)
    5 FORMAT("1")
      IF((IOPT.EQ.1).OR.(IOPT.EQ.3).OR.(IOPT.EQ.5)) PRINT (ICHT,10)
      IF((IOPT.EQ.2).OR.(IOPT.EQ.4).OR.(IOPT.EQ.6)) PRINT (ICHT,11)
   10 FORMAT(5X,"** OPTIMAL SCHEDULE FOR THE PRODUCER **"/)
   11 FORMAT(5X,"** OPTIMAL SCHEDULE FOR THE UTILITY **"/)
      PRINT (ICHT,12) PSOL(1)
   12 FORMAT(5X,"INITIAL STORAGE ENERGY LEVEL=",F8.2//)
      PRINT (ICHT,15)
   15 FORMAT
     + (7X,"PRODUCE",5X,"COGEN",6X,"USE",7X,"SELL",6X," BUY",5X,"STORE"
     + ,6X,"LEVEL",5X,"LOSS",4X,"PROFIT")
      PRINT (ICHT,17)
   17 FORMAT(2X,"PERIOD")

      IF((IOPT.EQ.1).OR.(IOPT.EQ.2)) ISOE=7
      IF((IOPT.EQ.3).OR.(IOPT.EQ.4)) ISOE=8
      IF((IOPT.EQ.5).OR.(IOPT.EQ.6)) ISOE=10
      IF((ISOE.EQ.7).OR.(ISOE.EQ.8)) BETA=0.

      STORED=PSOL(1)
      DO 20 K=1,N
      I2=ISOE*(K-1)+1
      PRODUCE=PSOL(I2+2)+PSOL(I2+3)/RGAM+PSOL(I2+4)
      USE=PSOL(I2+4)+RGAM*PSOL(I2+5)+PSOL(I2+6)
      COGEN=BETA*USE
      IF((IOPT.EQ.3).OR.(IOPT.EQ.4)) U(K)=USE
      IF((IOPT.EQ.5).OR.(IOPT.EQ.6)) U(K)=USE
      STR=0
      DSC=0
      IF((IOPT.EQ.5).OR.(IOPT.EQ.6)) STR=PSOL(I2+9)
      IF((IOPT.EQ.5).OR.(IOPT.EQ.6)) DSC=PSOL(I2+10)
      SELL=PSOL(I2+3)+PSOL(I2+7)+DSC
      BUY=PSOL(I2+1)+PSOL(I2+5)
      SCH(K)=SELL-BUY
      STORE=
     +EPS*(PSOL(I2+1)+PSOL(I2+2)+STR)-(PSOL(I2+6)+PSOL(I2+7))/DEL
      STORED=STORED*RMEU+STORE
      RLOSS=(1-EPS)*(PSOL(I2+1)+PSOL(I2+2)+STR)
     + +(1-DEL)*(PSOL(I2+6)+PSOL(I2+7))/DEL
     + +(1-RGAM)*(PSOL(I2+3)/RGAM+PSOL(I2+5))
      PROFIT=SELL*P(K)-BUY*Q(K)-PRODUCE*R(K)
      PRINT (ICHT,25)
     + K,PRODUCE,COGEN,USE,SELL,BUY,STORE,STORED,RLOSS,PROFIT
   25 FORMAT(2X,I2,2X,9(F8.2,2X))
   20 CONTINUE
      PRINT (ICHT,30) SMAX
```

```
          30     FORMAT(5X,"TOTAL REVENUE=",F10.2)
                 RETURN
                 END
```

SYMBOLIC REFERENCE MAP (R=1)

```
ENTRY POINTS
    3  PRSCH

VARIABLES     SN  TYPE            RELOCATION
    0  BETA       REAL                 F.P.           333  BUY        REAL
  327  COGEN      REAL                                  0  DEL        REAL                 F.P.
  331  DSC        REAL                                  0  EPS        REAL                 F.P.
    0  ICHT       INTEGER              F.P.             0  IOPT       INTEGER              F.P.
  321  ISOE       INTEGER                             324  I2         INTEGER
  323  K          INTEGER                               0  MD1        INTEGER              F.P.
    0  MD3        INTEGER              F.P.             0  N          INTEGER              F.P.
    0  P          REAL       ARRAY     F.P.           325  PRODUCE    REAL
  336  PROFIT     REAL                                  0  PSOL       REAL       ARRAY     F.P.
    0  Q          REAL       ARRAY     F.P.             0  R          REAL       ARRAY     F.P.
    0  RGAM       REAL                 F.P.           335  RLOSS      REAL
    0  RMEU       REAL                 F.P.             0  SCH        REAL       ARRAY     F.P.
  332  SELL       REAL                                  0  SMAX       REAL                 F.P.
  334  STORE      REAL                                322  STORED     REAL
  330  STR        REAL                                  0  U          REAL       ARRAY     F.P.
  326  USE        REAL

STATEMENT LABELS
  206  5      FMT                       216  10      FMT                       224  11
  236  12     FMT                       247  15      FMT                       265  17
    0  20                               305  25      FMT                       314  30

LOOPS  LABEL    INDEX     FROM-TO    LENGTH     PROPERTIES
   70  20       K           32 56      107B               EXT REFS

STATISTICS
  PROGRAM LENGTH                 365B      245
          52000B CM USED
```

```
      SUBROUTINE PLTSQ(XL,YL,FACT,SMAX,ICOMM1,ICOMM2,ICOMM3)
C
C     THIS ROUTINE PLOTS A SQUARE AND PRINTS THE COMMENT.
C
      CALL FACTOR(FACT)
      CALL PLOT(0.,0.,-3)
      CALL PLOT(0.,YL,-2)
      CALL PLOT(XL,0.,-2)
      CALL PLOT(0.,-YL,-2)
      CALL PLOT(-XL,0.,-2)
      CALL SYMBOL(1.,YL-1.,.5,ICOMM1,0.,10)
      CALL SYMBOL(5.5,YL-1.,.5,ICOMM2,0.,10)
      CALL SYMBOL(10.5,YL-1.,.5,ICOMM3,0.,10)
      CALL SYMBOL(1.,YL-2.,.5,"PROFIT = $",0.,10)
      CALL NUMBER(6.,YL-2.,.5,SMAX,0.,2)
      RETURN
      END
```

```
SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  PLTSQ

VARIABLES      SN  TYPE         RELOCATION
    0  FACT        REAL              F.P.        0  ICOMM1    INTEGER          F.P.
    0  ICOMM2      INTEGER           F.P.        0  ICOMM3    INTEGER          F.P.
    0  SMAX        REAL              F.P.        0  XL        REAL             F.P.
    0  YL          REAL              F.P.

EXTERNALS            TYPE   ARGS
       FACTOR                 1                     NUMBER              6
       PLOT                   3                     SYMBOL              6

STATISTICS
  PROGRAM LENGTH                  172B      122
      52000B CM USED
```

```
      SUBROUTINE PLT1(A,OX,OY,DT,N,FAC,IX,JY,I1,J1,MD1)

      REAL A(MD1),XA(512),YA(512)
      REAL IX(2),JY(2)

C
C     THIS ROUTINE PLOTS THE NUMBERS IN THE ARRAY A.
C

      CALL PLOT(OX,OY,-3)
      CALL PLOT(0.,-.5,3)
      CALL FACTOR(FAC)

      N1=N-1
      N2=2*N
      DTC=0.
      XA(1)=0.
      YA(1)=A(1)
      DO 10 I=1,N1
      DTC=DTC+DT
      XA(2*I)=DTC
      XA(2*I+1)=DTC
      YA(2*I)=A(I)
      YA(2*I+1)=A(I+1)
   10 CONTINUE
      XA(N2)=N*DT
      YA(N2)=A(N)

      CALL SCALE(XA,6.5,N2,1)
      CALL SCALE(YA,4.5,N2,1)
      CALL AXIS(0.,0.,IX,-I1,6.5,0.,XA(N2+1),XA(N2+2))
      CALL AXIS(0.,0.,JY,J1,4.5,90.,YA(N2+1),YA(N2+2))
      CALL LINE(XA,YA,N2,1,0,0)

      RETURN
      END
```

SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
3 PLT1

VARIABLES		TYPE	RELOCATION						
0	A	REAL	ARRAY	F.P.	0	DT	REAL		F.P.
163	DTC	REAL			0	FAC	REAL		F.P.
164	I	INTEGER			0	IX	REAL	ARRAY	F.P.
0	I1	INTEGER		F.P.	0	JY	REAL	ARRAY	F.P.
0	J1	INTEGER		F.P.	0	MD1	INTEGER		F.P.
0	N	INTEGER		F.P.	161	N1	INTEGER		
162	N2	INTEGER			0	OX	REAL		F.P.
0	OY	REAL		F.P.	165	XA	REAL	ARRAY	
1165	YA	REAL	ARRAY						

```
       SUBROUTINE PLT1         74/835   OPT=1                                FTN 4.8+628          85/06

EXTERNALS            TYPE    ARGS
       AXIS                    8                          FACTOR                 1
       LINE                    6                          PLOT                   3
       SCALE                   4

STATEMENT LABELS
    0  10

LOOPS  LABEL      INDEX       FROM-TO     LENGTH     PROPERTIES
   33  10         I             19 25         6B         OPT

STATISTICS
  PROGRAM LENGTH                  2167B     1143
          52000B CM USED
```

```
                   SUBROUTINE IN11
                 + (ICHT,IOPT,DT,R1,R2,S,EPS,DEL,RGAM,RMEU,N,P,Q,R,G,U,MD1)

                   REAL P(MD1),Q(MD1),R(MD1),G(MD1),U(MD1)

            C
            C      THIS ROUTINE OUTPUTS THE FINAL PRICES AND OTHER INFORMATION.
            C

            C      PRINT (ICHT,2)
            C2     FORMAT ("1")
                   IC="C"
                   PRINT (ICHT,5) IC
             5     FORMAT(A1)
                   PRINT (ICHT,*) IOPT,DT,N
            C      PRINT (ICHT,6) IOPT,DT,N
            C6     FORMAT(5X,"IOPT=",I2,5X,"DT=",F8.2,2X,"N=",I5/)
                   PRINT (ICHT,5) IC
                   PRINT (ICHT,*) R1,R2,S,EPS,DEL
            C      PRINT (ICHT,7) R1,R2,S,EPS,DEL
            C7     FORMAT(5X,"R1=",F8.2,2X,"R2=",F8.2,2X,"S=",F8.2,2X,
            C    + "EPS=",F5.3,5X,"DEL=",F5.3,5X)
                   PRINT (ICHT,5) IC
                   PRINT (ICHT,*) RGAM,RMEU
            C      PRINT (ICHT,8) RGAM,RMEU
            C8     FORMAT(5X,"GAMMA=",F5.3,5X,"MEU=",F5.3/)
                   PRINT (ICHT,5) IC
            C      PRINT (ICHT,9)
            C9     FORMAT(9X,"K",4X,"P(K)",6X,"Q(K)",6X,"R(K)",8X,"G(K)",6X,"U(K)")
                   DO 10 K=1,N
                   PRINT (ICHT,*) K,P(K),Q(K),R(K),G(K),U(K)
            C      PRINT (ICHT,15) K,P(K),Q(K),R(K),G(K),U(K)
            C15    FORMAT(5X,I5,3(F8.4,2X),2(F10.2))
             10    CONTINUE
                   PRINT (ICHT,5) IC
                   RETURN
                   END
```

SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
3 IN11

VARIABLES SN		TYPE		RELOCATION	SN		TYPE		RELOCATION
0	DEL	REAL		F.P.	0	DT	REAL		F.P.
0	EPS	REAL		F.P.	0	G	REAL	ARRAY	F.P.
125	IC	INTEGER			0	ICHT	INTEGER		F.P.
0	IOPT	INTEGER		F.P.	126	K	INTEGER		
0	MD1	INTEGER		F.P.	0	N	INTEGER		F.P.
0	P	REAL	ARRAY	F.P.	0	Q	REAL	ARRAY	F.P.
0	R	REAL	ARRAY	F.P.	0	RGAM	REAL		F.P.
0	RMEU	REAL		F.P.	0	R1	REAL		F.P.
0	R2	REAL		F.P.	0	S	REAL		F.P.

```
      SUBROUTINE IN11       74/835  OPT=1                                  FTN 4.8+628         85/06

VARIABLES      SN  TYPE          RELOCATION
   0  U            REAL       ARRAY     F.P.

STATEMENT LABELS
   52  5        FMT                           0  10

LOOPS   LABEL     INDEX      FROM-TO     LENGTH     PROPERTIES
   26  10         K            30 34        15B                EXT REFS

STATISTICS
  PROGRAM LENGTH                 136B       94
          52000B CM USED
```

DATE: 11 JUN 85 AT 17:07:52

DEPARTMENT: DFAULT:JDL*

JOB ID: 908 REPORT NO. 69

FILE ID:

INPUT PROCESSING TIME: 00:00:22

OUTPUT PROCESSING TIME: 00:00:26

REPORT COMPLETION CODE: 50

PAGES TO BIN: 31

PAGES TO TRAY: 0

PAPER PATH HOLES: 11

LINES PRINTED: 1343 GRAPHIC PAGES PRINTED: 1

ONLINE IDLE (SEC): 0 GRAPHIC EXCEPTION CODE: 0

BLOCKS READ: 0 GRAPHIC IMAGES READ: 0

BLOCKS SKIPPED: 0 GRAPHIC IMAGES MOVED: 0

RECORDS READ: 1348

DJDE RECORDS READ: 9

MAXIMUM COPY COUNT: 1

OVERPRINTS: 0

COLLATE: YES

SF/MF: MULTI

SIMPLEX/DUPLEX: BOTH

JDE,JDL USED: DFLT,DFAULT

ACCTINFO:

INITIAL FONT LIST: L0112B

(DJDE MODIFIED)

INITIAL FORM LIST: BANNER

(DJDE MODIFIED)

INITIAL CME LIST: -NONE

APPENDIX 6

PROGRAM TSTG1

LISTING

```
      PROGRAM TSTG1
     + (INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,TAPE9)

      COMMON /BLK1/ PS(24),QS(24),RS(24),GS(24),US(24)
      REAL A(195,193),B(195),C(193),C1(193)
      REAL PSOL(193),DSOL(195),RW(38522),IW(497)
      REAL P(24),Q(24),R(24),G(24),U(24)
      REAL IBUF(512),SCH(24)

C
C     THIS PROGRAM COMPUTES THE OPTIMUM STORAGE CAPACITY FOR THE OPERATION
C     LOCAL SMALL POWER PRODUCER.
C
C     PROGRAMMER : HASSAN GHOUDJEHBAKLOU
C     DATE       : 3/1/84
C
C     OPTIONS : IOPT=
C                                PRODUCER   UTILITY
C                               -----------------
C     FIXED                     !   1    !    2  !
C                               -----------------
C     SHIFTABLE                 !   3    !    4  !
C                               -----------------
C     COGENERATION              !   5    !    6  !
C                               -----------------
C
C
C
C     M1 = NUMBER OF INEQUALITIES
C     M2 = NUMBER OF EQUALITIES
C     24=N
C
C
C     DIMENSIONS
C     M1=7*N-1
C     M2=N+2
C     M1+M2=8*N+1
C     195=M1+M2+2=8*N+3
C     193=8*N+1
C     38522=(M1+M2+2)*(M1+M2+2)+3*M1+2*M2+4
C     496  =2*M2+3*M1+4
C

      ICHR=5
      ICHW=6

      MD1=24
      MD2=195
      MD3=193

      PRINT (ICHW,2)
    2 FORMAT("1")
      READ (ICHR,5) IC,NAME
    5 FORMAT(A1,1X,A10)
      READ (ICHR,*) IOPT,DT,N
      PRINT (ICHW,6) IOPT,DT,N,NAME
    6 FORMAT(5X,"IOPT=",I2,5X,"DT=",F8.2,2X,"N=",I5
```

```
     + ,2X,"NAME =",A10)

       IF ((IOPT.EQ.1).OR.(IOPT.EQ.2)) CALL IN1
     + (ICHR,ICHW,R1,R2,ALFA,EPS,DEL,RGAM,RMEU,N,P,Q,R,G,U,MD1)
       IF((IOPT.EQ.3).OR.(IOPT.EQ.4)) CALL IN2
     + (ICHR,ICHW,R1,R2,ALFA,EPS,DEL,RGAM,RMEU,N,P,Q,R,G,UT,UL,UH,MD1)
       IF((IOPT.EQ.5).OR.(IOPT.EQ.6)) CALL IN3
     + (ICHR,ICHW,R1,R2,ALFA,BETA,EPS,DEL,RGAM,RMEU,N,P,Q,R,G,UT,UL,UH,
     + MD1)

       IF((IOPT.EQ.1).OR.(IOPT.EQ.2)) CALL FRMLP1
     + (R1,R2,ALFA,EPS,DEL,RGAM,RMEU,DT,N,P,Q,R,G,U,MD1,
     + A,B,C,C1,M1,M2,NP,MD2,MD3)
       IF((IOPT.EQ.3).OR.(IOPT.EQ.4)) CALL FRMLP2
     + (R1,R2,ALFA,EPS,DEL,RGAM,RMEU,DT,N,P,Q,R,G,UT,UL,UH,MD1,
     + A,B,C,C1,M1,M2,NP,MD2,MD3)
       IF((IOPT.EQ.5).OR.(IOPT.EQ.6)) CALL FRMLP3
     + (R1,R2,ALFA,BETA,EPS,DEL,RGAM,RMEU,DT,N,P,Q,R,G,UT,UL,UH,MD1,
     + A,B,C,C1,M1,M2,NP,MD2,MD3)

       IF((IOPT.EQ.1).OR.(IOPT.EQ.3).OR.(IOPT.EQ.5)) CALL ZX3LP
     + (A,MD2,B,C,NP,M1,M2,SMAX,PSOL,DSOL,RW,IW,IER)
       IF((IOPT.EQ.2).OR.(IOPT.EQ.4).OR.(IOPT.EQ.6)) CALL ZX3LP
     + (A,MD2,B,C1,NP,M1,M2,SMAX,PSOL,DSOL,RW,IW,IER)

       CALL OUT(ICHW,IOPT,PSOL,N,SMAX,IER,MD3)

       CALL PRSCH
     +(ICHW,IOPT,P,Q,R,U,PSOL,SCH,N,SMAX,BETA,EPS,DEL,RGAM,RMEU,MD1,MD3)

C      READ (ICHR,10) ICOMM1,ICOMM2,ICOMM3
C10    FORMAT(8A10)
C      CALL PLOTS(IBUF,512,9,00)
C      CALL PLTSQ(15.,15.,.5,SMAX,PSOL(2),ICOMM1,ICOMM2,ICOMM3)
C      CALL PLT1(P,1.,7.,DT,N,.5,"TIME","SELL $/KWH",4,10,MD1)
C      CALL PLT1(Q,7.,0.,DT,N,.5,"TIME","BUY $/KWH",4,9,MD1)
C      CALL PLT1(U,-7.,-6.,DT,N,.5,"TIME","USE $/KWH",4,9,MD1)
C      CALL PLT1(SCH,7.,0.,DT,N,.5,"TIME","SCHEDULE KWH",4,12,MD1)
C      CALL PLOT(0.,0.,999)
       STOP
       END
```

SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
6217 TSTG1

VARIABLES		SN	TYPE	RELOCATION				
6716	A		REAL	ARRAY	6700	ALFA	REAL	
120321	B		REAL	ARRAY	6710	BETA	REAL	
120624	C		REAL	ARRAY	121125	C1	REAL	ARRAY
6702	DEL		REAL		121727	DSOL	REAL	ARRAY
6674	DT		REAL		6701	EPS	REAL	

VARIABLES SN TYPE RELOCATION

236515	G	REAL	ARRAY		110	GS	REAL	ARRAY	BLK1
236575	IBUF	REAL	*UNDEF		6671	IC	INTEGER		
6664	ICHR	INTEGER			6665	ICHW	INTEGER		
6715	IER	INTEGER			6673	IOPT	INTEGER		
235424	IW	REAL	ARRAY		6666	MD1	INTEGER		
6667	MD2	INTEGER			6670	MD3	INTEGER		
6711	M1	INTEGER			6712	M2	INTEGER		
6675	N	INTEGER			6672	NAME	INTEGER		
6713	NP	INTEGER			236405	P	REAL	ARRAY	
0	PS	REAL	ARRAY	BLK1	121426	PSOL	REAL	ARRAY	
236435	Q	REAL	ARRAY		30	QS	REAL	ARRAY	BLK1
236465	R	REAL	ARRAY		6703	RGAM	REAL		
6704	RMEU	REAL			60	RS	REAL	ARRAY	BLK1
122232	RW	REAL	ARRAY		6676	R1	REAL		
6677	R2	REAL			237575	SCH	REAL	ARRAY	
6714	SMAX	REAL			236545	U	REAL	ARRAY	
6707	UH	REAL			6706	UL	REAL		
140	US	REAL	ARRAY	BLK1	6705	UT	REAL		

FILE NAMES MODE

0	INPUT	2054	OUTPUT	0	TAPE5	2
4130	TAPE9					

EXTERNALS TYPE ARGS

FRMLP1	24	FRMLP2	26
FRMLP3	27	IN1	16
IN2	18	IN3	19
OUT	7	PRSCH	17
ZX3LP	13		

STATEMENT LABELS

6625	2	FMT	6635	5	FMT	6654	6

COMMON BLOCKS LENGTH

BLK1	120

STATISTICS

PROGRAM LENGTH	231735B	78813
BUFFER LENGTH	5670B	3000
CM LABELED COMMON LENGTH	170B	120

52000B CM USED

```
      SUBROUTINE IN1
     + (ICHR,ICHW,R1,R2,ALFA,EPS,DEL,RGAM,RMEU,N,P,Q,R,G,U,MD1)

      COMMON /BLK1/ PS(24),QS(24),RS(24),GS(24),US(24)
      REAL P(MD1),Q(MD1),R(MD1),G(MD1),U(MD1)

C
C     THIS ROUTINE READS THE INPUT FILE AND PRINTS OUT A COPY OF THEM.
C

      READ (ICHR,5) IC
    5 FORMAT(A1)
      READ (ICHR,*) R1,R2,ALFA,EPS,DEL
      PRINT (ICHW,7) R1,R2,ALFA,EPS,DEL
    7 FORMAT(5X,"R1=",F8.2,2X,"R2=",F8.2,2X,"ALFA=",F8.5,2X,
     + "EPS=",F5.3,5X,"DEL=",F5.3,5X)
      READ (ICHR,5) IC
      READ (ICHR,*) RGAM,RMEU
      PRINT (ICHW,8) RGAM,RMEU
    8 FORMAT (5X,"GAMMA=",F5.3,5X,"MEU=",F5.3/)
      READ (ICHR,5) IC
      PRINT (ICHW,9)
    9 FORMAT(8X,"K",5X,"P(K)",6X,"Q(K)",6X,"R(K)",8X,"G(K)",6X,"U(K)")
      DO 11 I=1,MD1
      READ (ICHR,*) K,PS(K),QS(K),RS(K),GS(K),US(K)
   11 CONTINUE
      IDT=MD1/N
      DO 10 K=1,N
      I1=IDT*(K-1)
      P(K)=0.
      Q(K)=0.
      R(K)=0.
      G(K)=0.
      U(K)=0.
      DO 12 J=1,IDT
      P(K)=P(K)+PS(I1+J)
      Q(K)=Q(K)+QS(I1+J)
      R(K)=R(K)+RS(I1+J)
      G(K)=G(K)+GS(I1+J)
      U(K)=U(K)+US(I1+J)
   12 CONTINUE
      P(K)=P(K)/IDT
      Q(K)=Q(K)/IDT
      R(K)=R(K)/IDT
      PRINT (ICHW,15) K,P(K),Q(K),R(K),G(K),U(K)
   15 FORMAT(5X,I4,1X,3(F8.4,2X),2(F10.2))
   10 CONTINUE
      READ (ICHR,5) IC
      RETURN
      END
```

SYMBOLIC REFERENCE MAP (R=1)

```
ENTRY POINTS
    3  IN1

VARIABLES       SN  TYPE            RELOCATION
    0  ALFA         REAL                  F.P.           0  DEL         REAL                 F.P.
    0  EPS          REAL                  F.P.           0  G           REAL       ARRAY     F.P.
  110  GS           REAL       ARRAY   BLK1            265  I           INTEGER
  264  IC           INTEGER                              0  ICHR        INTEGER              F.P.
    0  ICHW         INTEGER               F.P.         267  IDT         INTEGER
  270  I1           INTEGER                            271  J           INTEGER
  266  K            INTEGER                              0  MD1         INTEGER              F.P.
    0  N            INTEGER               F.P.           0  P           REAL       ARRAY     F.P.
    0  PS           REAL       ARRAY   BLK1              0  Q           REAL       ARRAY     F.P.
   30  QS           REAL       ARRAY   BLK1              0  R           REAL       ARRAY     F.P.
    0  RGAM         REAL                  F.P.           0  RMEU        REAL                 F.P.
   60  RS           REAL       ARRAY   BLK1              0  R1          REAL                 F.P.
    0  R2           REAL                  F.P.           0  U           REAL       ARRAY     F.P.
  140  US           REAL       ARRAY   BLK1

STATEMENT LABELS
  132  5        FMT                    154  7       FMT                      204  8
  221  9        FMT                      0  10                                 0  11
    0  12                              253  15      FMT

LOOPS  LABEL     INDEX     FROM-TO     LENGTH     PROPERTIES
   27  11        I          24 26        16B                 EXT REFS
   52  10        K          28 47        50B                 EXT REFS  NOT INNER
   65  12        J          35 41        13B        OPT

COMMON BLOCKS    LENGTH
       BLK1         120

STATISTICS
  PROGRAM LENGTH                  317B      207
  CM LABELED COMMON LENGTH        170B      120
        52000B CM USED
```

```
              SUBROUTINE IN2
             + (ICHR,ICHW,R1,R2,ALFA,EPS,DEL,RGAM,RMEU,N,P,Q,R,G,UT,UL,UH,MD1)

              COMMON /BLK1/ PS(24),QS(24),RS(24),GS(24),US(24)
              REAL P(MD1),Q(MD1),R(MD1),G(MD1)

        C
        C     THIS ROUTINE READS THE INPUT FILE AND PRINTS OUT A COPY OF THEM.
        C

              READ (ICHR,5) IC
          5   FORMAT(A1)
              READ (ICHR,*) R1,R2,ALFA,EPS,DEL
              PRINT (ICHW,7) R1,R2,ALFA,EPS,DEL
          7   FORMAT(5X,"R1=",F8.2,2X,"R2=",F8.2,2X,"ALFA=",F8.5,2X,
             + "EPS=",F5.3,5X,"DEL=",F5.3,5X)
              READ (ICHR,5) IC
              READ (ICHR,*) RGAM,RMEU
              PRINT (ICHW,6) RGAM,RMEU
          6   FORMAT (5X,"GAMMA=",F5.3,5X,"MEU=",F5.3)
              READ (ICHR,5) IC
              READ (ICHR,*) UT,UL,UH
              PRINT (ICHW,8) UT,UL,UH
          8   FORMAT(5X,"UT=",F8.2,2X,"UL=",F8.2,2X,"UH=",F8.2/)
              READ (ICHR,5) IC
              PRINT (ICHW,9)
          9   FORMAT(8X,"K",5X,"P(K)",6X,"Q(K)",6X,"R(K)",8X,"G(K)")
              DO 11 I=1,MD1
              READ (ICHR,*) K,PS(K),QS(K),RS(K),GS(K),TEMP
         11   CONTINUE
              IDT=MD1/N
              DO 10 K=1,N
              I1=IDT*(K-1)
              P(K)=0.
              Q(K)=0.
              R(K)=0.
              G(K)=0.
              DO 12 J=1,IDT
              P(K)=P(K)+PS(I1+J)
              Q(K)=Q(K)+QS(I1+J)
              R(K)=R(K)+RS(I1+J)
              G(K)=G(K)+GS(I1+J)
         12   CONTINUE
              P(K)=P(K)/IDT
              Q(K)=Q(K)/IDT
              R(K)=R(K)/IDT
              PRINT (ICHW,15) K,P(K),Q(K),R(K),G(K)
         15   FORMAT(5X,I4,1X,3(F8.4,2X),F10.2)
         10   CONTINUE
              READ (ICHR,5) IC
              RETURN
              END
```

```
       SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  IN2

VARIABLES      SN  TYPE            RELOCATION
    0  ALFA        REAL                    F.P.             0  DEL          REAL                   F.P.
    0  EPS         REAL                    F.P.             0  G            REAL        ARRAY      F.P.
  110  GS          REAL        ARRAY     BLK1             314  I            INTEGER
  313  IC          INTEGER                                  0  ICHR         INTEGER                F.P.
    0  ICHW        INTEGER                 F.P.           317  IDT          INTEGER
  320  I1          INTEGER                                321  J            INTEGER
  315  K           INTEGER                                  0  MD1          INTEGER                F.P.
    0  N           INTEGER                 F.P.             0  P            REAL        ARRAY      F.P.
    0  PS          REAL        ARRAY     BLK1               0  Q            REAL        ARRAY      F.P.
   30  QS          REAL        ARRAY     BLK1               0  R            REAL        ARRAY      F.P.
    0  RGAM        REAL                    F.P.             0  RMEU         REAL                   F.P.
   60  RS          REAL        ARRAY     BLK1               0  R1           REAL                   F.P.
    0  R2          REAL                    F.P.           316  TEMP         REAL
    0  UH          REAL                    F.P.             0  UL           REAL                   F.P.
  140  US          REAL        ARRAY     BLK1               0  UT           REAL                   F.P.

STATEMENT LABELS
  134  5       FMT                        206  6       FMT                         156  7
  234  8       FMT                        252  9       FMT                           0  10
    0  11                                   0  12                                  302  15

LOOPS  LABEL     INDEX     FROM-TO    LENGTH     PROPERTIES
   35  11        I          28 30       15B                EXT REFS
   57  10        K          32 49       45B                EXT REFS  NOT INNER
   74  12        J          38 43       10B        OPT

COMMON BLOCKS    LENGTH
       BLK1         120

STATISTICS
  PROGRAM LENGTH                 345B      229
  CM LABELED COMMON LENGTH       170B      120
         52000B CM USED
```

```
      SUBROUTINE IN3
     + (ICHR,ICHW,R1,R2,ALFA,BETA,EPS,DEL,RGAM,RMEU,N,P,Q,R,G,UT,UL,UH,
     + MD1)

      COMMON /BLK1/ PS(24),QS(24),RS(24),GS(24),US(24)
      REAL P(MD1),Q(MD1),R(MD1),G(MD1)

C
C     THIS ROUTINE READS THE INPUT FILE AND PRINTS OUT A COPY OF THEM.
C

      READ (ICHR,5) IC
    5 FORMAT(A1)
      READ (ICHR,*) R1,R2,ALFA,EPS,DEL
      PRINT (ICHW,7) R1,R2,ALFA,EPS,DEL
    7 FORMAT(5X,"R1=",F8.2,2X,"R2=",F8.2,2X,"ALFA=",F8.5,2X,
     + "EPS=",F5.3,5X,"DEL=",F5.3)
      READ (ICHR,5) IC
      READ (ICHR,*) BETA,RGAM,RMEU
      PRINT (ICHW,6) BETA,RGAM,RMEU
    6 FORMAT (5X,"BETA=",F5.3,5X,"GAMMA=",F5.3,5X,"MEU=",F5.3)
      READ (ICHR,5) IC
      READ (ICHR,*) UT,UL,UH
      PRINT (ICHW,8) UT,UL,UH
    8 FORMAT(5X,"UT=",F8.2,2X,"UL=",F8.2,2X,"UH=",F8.2/)
      READ (ICHR,5) IC
      PRINT (ICHW,9)
    9 FORMAT(8X,"K",5X,"P(K)",6X,"Q(K)",6X,"R(K)",8X,"G(K)")
      DO 11 I=1,MD1
      READ (ICHR,*) K,PS(K),QS(K),RS(K),GS(K),TEMP
   11 CONTINUE
      IDT=MD1/N
      DO 10 K=1,N
      I1=IDT*(K-1)
      P(K)=0.
      Q(K)=0.
      R(K)=0.
      G(K)=0.
      DO 12 J=1,IDT
      P(K)=P(K)+PS(I1+J)
      Q(K)=Q(K)+QS(I1+J)
      R(K)=R(K)+RS(I1+J)
      G(K)=G(K)+GS(I1+J)
   12 CONTINUE
      P(K)=P(K)/IDT
      Q(K)=Q(K)/IDT
      R(K)=R(K)/IDT
      PRINT (ICHW,15) K,P(K),Q(K),R(K),G(K)
   15 FORMAT(5X,I4,1X,3(F8.4,2X),F10.2)
   10 CONTINUE
      READ (ICHR,5) IC
      RETURN
      END
```

```
      SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  IN3

VARIABLES       SN  TYPE            RELOCATION
    0  ALFA         REAL                   F.P.          0  BETA       REAL                  F.P.
    0  DEL          REAL                   F.P.          0  EPS        REAL                  F.P.
    0  G            REAL        ARRAY      F.P         110  GS         REAL        ARRAY     BLK1
  317  I            INTEGER                            316  IC         INTEGER
    0  ICHR         INTEGER                F.P.          0  ICHW       INTEGER               F.P.
  322  IDT          INTEGER                            323  I1         INTEGER
  324  J            INTEGER                            320  K          INTEGER
    0  MD1          INTEGER                F.P.          0  N          INTEGER               F.P.
    0  P            REAL        ARRAY      F.P.          0  PS         REAL        ARRAY     BLK1
    0  Q            REAL        ARRAY      F.P.         30  QS         REAL        ARRAY     BLK1
    0  R            REAL        ARRAY      F.P.          0  RGAM       REAL                  F.P.
    0  RMEU         REAL                   F.P.         60  RS         REAL        ARRAY     BLK1
    0  R1           REAL                   F.P.          0  R2         REAL                  F.P.
  321  TEMP         REAL                                 0  UH         REAL                  F.P.
    0  UL           REAL                   F.P.        140  US         REAL        ARRAY     BLK1
    0  UT           REAL                   F.P.

STATEMENT LABELS
  134  5        FMT                    210  6      FMT                         156  7
  237  8        FMT                    255  9      FMT                           0  10
    0  11                                0  12                                 305  15

LOOPS  LABEL    INDEX    FROM-TO    LENGTH    PROPERTIES
   35  11       I          29 31       15B             EXT REFS
   57  10       K          33 50       45B             EXT REFS  NOT INNER
   74  12       J          39 44       10B        OPT

COMMON BLOCKS   LENGTH
       BLK1        120

STATISTICS
  PROGRAM LENGTH                350B     232
  CM LABELED COMMON LENGTH      170B     120
        52000B CM USED
```

```
      SUBROUTINE FRMLP1(R1,R2,ALFA,EPS,DEL,RGAM,RMEU,DT,N,P,Q,R,G,U,MD1,
     + A,B,C,C1,M1,M2,NP,MD2,MD3)

      REAL P(MD1),Q(MD1),R(MD1),G(MD1),U(MD1)
      REAL A(MD2,MD3),B(MD2),C(MD3),C1(MD3)

C
C     THIS ROUTINE FORMS THE OPERATING MATRICES FOR THE LINEAR
C     PROGRAMMING EXECUTION.
C

      M1=5*N-1
      M2=N+1
      NP=7*N+2

C     CLEAR A,B,C
      M3=M1+M2+2
      DO 2 I=1,M3
      B(I)=0
      DO 2 J=1,NP
      A(I,J)=0
    2 CONTINUE
      DO 3 J=1,NP
      C(J)=0
      C1(J)=0
    3 CONTINUE

C     M1 INEQUALITY CONSTRAINTS
      A(1,1)=1
      A(1,2)=-1
      B(1)=0
      C(2)=-ALFA*N*DT
      C1(2)=-ALFA*N*DT
      DO 30 K=1,N
      I1=3*(K-1)+1
      I2=7*(K-1)+2
      A(I1+1,I2+1)=EPS
      A(I1+1,I2+2)=EPS
      B(I1+1)=R1*DT

      A(I1+2,I2+2)=1
      A(I1+2,I2+3)=1.0/RGAM
      A(I1+2,I2+4)=1
      B(I1+2)=G(K)

      A(I1+3,I2+6)=1.0/DEL
      A(I1+3,I2+7)=1.0/DEL
      B(I1+3)=R2*DT
   30 CONTINUE

      TMEU1=1.0/RMEU
      N1=N-1
      DO 40 J=1,N1
      TMEU2=1.0/RMEU
      TMEU1=TMEU1*RMEU
      J1=2*(J-1)
      A(I1+J1+4,1)=TMEU1
```

```
      A(I1+J1+4,2)=-1.0
      A(I1+J1+5,1)=-TMEU1
      B(I1+J1+4)=0
      B(I1+J1+5)=0
      DO 50 K1=1,J
      TMEU2=TMEU2*RMEU
      K=J-K1+1
      K2=7*(K-1)+2
      A(I1+J1+4,K2+1)=EPS*TMEU2
      IF (K.NE.J) A(I1+J1+5,K2+1)=-EPS*TMEU2
      A(I1+J1+4,K2+2)=EPS*TMEU2
      IF (K.NE.J) A(I1+J1+5,K2+2)=-EPS*TMEU2
      A(I1+J1+4,K2+6)=-TMEU2/DEL
      A(I1+J1+5,K2+6)=TMEU2/DEL
      A(I1+J1+4,K2+7)=-TMEU2/DEL
      A(I1+J1+5,K2+7)=TMEU2/DEL
   50 CONTINUE
   40 CONTINUE

C     M2 EQUALITY CONSTRAINTS

      DO 60 K=1,N
      I2=7*(K-1)+2
      A(M1+K,I2+4)=1
      A(M1+K,I2+5)=RGAM
      A(M1+K,I2+6)=1
      B(M1+K)=U(K)
   60 CONTINUE

      A(M1+N+1)=TMEU2*RMEU-1.0
      C(1)=-1.0E-8
      TMEU1=1.0/RMEU
      DO 70 K1=1,N
      TMEU1=TMEU1*RMEU
      K=N-K1+1
      I2=7*(K-1)+2
      A(M1+N+1,I2+1)=EPS*TMEU1
      A(M1+N+1,I2+2)=EPS*TMEU1
      A(M1+N+1,I2+6)=-TMEU1/DEL
      A(M1+N+1,I2+7)=-TMEU1/DEL
      C(I2+1)=-Q(K)
      C(I2+2)=-R(K)
      C(I2+3)=P(K)-R(K)/RGAM
      C(I2+4)=-R(K)
      C(I2+5)=-Q(K)
      C(I2+7)=P(K)

      C1(I2+1)=Q(K)
      C1(I2+3)=-P(K)
      C1(I2+5)=Q(K)
      C1(I2+7)=-P(K)

   70 CONTINUE
      B(M1+N+1)=0
      RETURN
      END
```

SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
3 FRMLP1

VARIABLES SN TYPE RELOCATION

0	A	REAL	ARRAY	F.P.	0	ALFA	REAL		F.P.
0	B	REAL	ARRAY	F.P.	0	C	REAL	ARRAY	F.P.
0	C1	REAL	ARRAY	F.P.	0	DEL	REAL		F.P.
0	DT	REAL		F.P.	0	EPS	REAL		F.P.
0	G	REAL	ARRAY	F.P.	365	I	INTEGER		
370	I1	INTEGER			371	I2	INTEGER		
366	J	INTEGER			375	J1	INTEGER		
367	K	INTEGER			376	K1	INTEGER		
377	K2	INTEGER			0	MD1	INTEGER		F.P.
0	MD2	INTEGER		F.P.	0	MD3	INTEGER		F.P.
0	M1	INTEGER		F.P.	0	M2	INTEGER		F.P.
364	M3	INTEGER			0	N	INTEGER		F.P.
0	NP	INTEGER		F.P.	373	N1	INTEGER		
0	P	REAL	ARRAY	F.P.	0	Q	REAL	ARRAY	F.P.
0	R	REAL	ARRAY	F.P.	0	RGAM	REAL		F.P.
0	RMEU	REAL		F.P.	0	R1	REAL		F.P.
0	R2	REAL		F.P.	372	TMEU1	REAL		
374	TMEU2	REAL			0	U	REAL	ARRAY	F.P.

STATEMENT LABELS

0	2	0	3	0	30
0	40	0	50	0	60
0	70				

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
21	2	I	18 22	15B	NOT INNER
30	2	J	20 22	2B	OPT
43	3	J	23 26	2B	OPT
117	30	K	34 49	22B	OPT
147	40	J	53 75	63B	NOT INNER
176	50	K1	62 74	30B	OPT
253	60	K	79 85	7B	OPT
312	70	K1	90 110	26B	OPT

STATISTICS
PROGRAM LENGTH 442B 290
52000B CM USED

```
      SUBROUTINE FRMLP2(R1,R2,ALFA,EPS,DEL,RGAM,RMEU,DT,N,P,Q,R,G,
     + UT,UL,UH,MD1,A,B,C,C1,M1,M2,NP,MD2,MD3)

      REAL P(MD1),Q(MD1),R(MD1),G(MD1)
      REAL A(MD2,MD3),B(MD2),C(MD3),C1(MD3)

C
C     THIS ROUTINE FORMS THE OPERATING MATRICES FOR THE LINEAR
C     PROGRAMMING EXECUTION.
C

      M1=7*N-1
      M2=N+2
      NP=8*N+2

C     CLEAR A,B,C
      M3=M1+M2+2
      DO 2 I=1,M3
      B(I)=0
      DO 2 J=1,NP
      A(I,J)=0
    2 CONTINUE
      DO 3 J=1,NP
      C(J)=0
      C1(J)=0
    3 CONTINUE

C     M1 INEQUALITY CONSTRAINTS
      A(1,1)=1
      A(1,2)=-1
      B(1)=0
      C(2)=-ALFA*N*DT
      C1(2)=-ALFA*N*DT
      DO 30 K=1,N
      I1=5*(K-1)+1
      I2=8*(K-1)+2
      A(I1+1,I2+1)=EPS
      A(I1+1,I2+2)=EPS
      B(I1+1)=R1*DT

      A(I1+2,I2+2)=1
      A(I1+2,I2+3)=1.0/RGAM
      A(I1+2,I2+4)=1
      B(I1+2)=G(K)

      A(I1+3,I2+6)=1.0/DEL
      A(I1+3,I2+7)=1.0/DEL
      B(I1+3)=R2*DT

      A(I1+4,I2+8)=1
      B(I1+4)=UH

      A(I1+5,I2+8)=-1
      B(I1+5)=-UL
   30 CONTINUE
      M4=5*N+1
```

```
      TMEU1=1.0/RMEU
      N1=N-1
      DO 40 J=1,N1
      TMEU2=1.0/RMEU
      TMEU1=TMEU1*RMEU
      J1=2*(J-1)
      A(M4+J1+1,1)=TMEU1
      A(M4+J1+1,2)=-1.0
      A(M4+J1+2,1)=-TMEU1
      B(M4+J1+1)=0
      B(M4+J1+2)=0
      DO 50 K1=1,J
      K=J-K1+1
      TMEU2=TMEU2*RMEU
      K2=8*(K-1)+2
      A(M4+J1+1,K2+1)=EPS*TMEU2
      IF(K.NE.J)  A(M4+J1+2,K2+1)=-EPS*TMEU2
      A(M4+J1+1,K2+2)=EPS*TMEU2
      IF(K.NE.J)  A(M4+J1+2,K2+2)=-EPS*TMEU2
      A(M4+J1+1,K2+6)=-TMEU2/DEL
      A(M4+J1+2,K2+6)=TMEU2/DEL
      A(M4+J1+1,K2+7)=-TMEU2/DEL
      A(M4+J1+2,K2+7)=TMEU2/DEL
   50 CONTINUE
   40 CONTINUE

C     M2 EQUALITY CONSTRAINTS

      DO 60 K=1,N
      I2=8*(K-1)+2
      A(M1+K,I2+4)=1
      A(M1+K,I2+5)=RGAM
      A(M1+K,I2+6)=1
      A(M1+K,I2+8)=-1
   60 CONTINUE

      A(M1+N+1,1)=TMEU2*RMEU-1.0
      C(1)=-1.0E-8
      TMEU1=TMEU1*RMEU
      DO 70 K1=1,N
      TMEU1=TMEU1*RMEU
      K=N-K1+1
      I2=8*(K-1)+2
      A(M1+N+1,I2+1)=EPS*TMEU1
      A(M1+N+1,I2+2)=EPS*TMEU1
      A(M1+N+1,I2+6)=-TMEU1/DEL
      A(M1+N+1,I2+7)=-TMEU1/DEL
      A(M1+N+2,I2+8)=1

      C(I2+1)=-Q(K)
      C(I2+2)=-R(K)
      C(I2+3)=P(K)-R(K)/RGAM
      C(I2+4)=-R(K)
      C(I2+5)=-Q(K)
      C(I2+7)=P(K)

      C1(I2+1)=Q(K)
```

```
  115                 C1(I2+3)=-P(K)
                      C1(I2+5)=Q(K)
                      C1(I2+7)=-P(K)

                70    CONTINUE
  120                 B(M1+N+1)=0
                      B(M1+N+2)=UT
                      RETURN
                      END
```

```
       SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  FRMLP2

VARIABLES       SN  TYPE          RELOCATION
    0  A            REAL       ARRAY     F.P.          0  ALFA       REAL                F.P.
    0  B            REAL       ARRAY     F.P.          0  C          REAL       ARRAY    F.P.
    0  C1           REAL       ARRAY     F.P.          0  DEL        REAL                F.P.
    0  DT           REAL                 F.P.          0  EPS        REAL                F.P.
    0  G            REAL       ARRAY     F.P.        415  I          INTEGER
  420  I1           INTEGER                          421  I2         INTEGER
  416  J            INTEGER                          426  J1         INTEGER
  417  K            INTEGER                          427  K1         INTEGER
  430  K2           INTEGER                            0  MD1        INTEGER             F.P.
    0  MD2          INTEGER              F.P.          0  MD3        INTEGER             F.P.
    0  M1           INTEGER              F.P.          0  M2         INTEGER             F.P.
  414  M3           INTEGER                          422  M4         INTEGER
    0  N            INTEGER              F.P.          0  NP         INTEGER             F.P.
  424  N1           INTEGER                            0  P          REAL       ARRAY    F.P.
    0  Q            REAL       ARRAY     F.P.          0  R          REAL       ARRAY    F.P.
    0  RGAM         REAL                 F.P.          0  RMEU       REAL                F.P.
    0  R1           REAL                 F.P.          0  R2         REAL                F.P.
  423  TMEU1        REAL                             425  TMEU2      REAL
    0  UH           REAL                 F.P.          0  UL         REAL                F.P.
    0  UT           REAL                 F.P.

STATEMENT LABELS
    0  2                                   0  3                                       0  30
    0  40                                  0  50                                      0  60
    0  70

LOOPS  LABEL     INDEX     FROM-TO     LENGTH    PROPERTIES
   20  2         I          18  22        15B              NOT INNER
   27  2         J          20  22         2B        OPT
   42  3         J          23  26         2B        OPT
  123  30        K          34  55        27B        OPT
  161  40        J          60  82        63B              NOT INNER
  210  50        K1         69  81        30B        OPT
  270  60        K          86  92         7B        OPT
  334  70        K1         97  119       30B        OPT
```

```
STATISTICS
  PROGRAM LENGTH              474B       316
          52000B CM USED
```

```
      SUBROUTINE FRMLP3
     + (R1,R2,ALFA,BETA,EPS,DEL,RGAM,RMEU,DT,N,P,Q,R,G,UT,UL,UH,MD1,
     + A,B,C,C1,M1,M2,NP,MD2,MD3)

      REAL P(MD1),Q(MD1),R(MD1),G(MD1)
      REAL A(MD2,MD3),B(MD2),C(MD3),C1(MD3)

C
C     THIS ROUTINE FORMS THE OPERATING MATRICES FOR THE LINEAR
C     PROGRAMMING EXECUTION.
C

      M1=7*N-1
      M2=2*N+2
      NP=10*N+2

C     CLEAR A,B,C
      M3=M1+M2+2
      DO 2 I=1,M3
      B(I)=0
      DO 2 J=1,NP
      A(I,J)=0
    2 CONTINUE
      DO 3 J=1,NP
      C(J)=0
      C1(J)=0
    3 CONTINUE

C     M1 INEQUALITY CONSTRAINTS
      A(1,1)=1
      A(1,2)=-1
      B(1)=0
      C(2)=-ALFA*N*DT
      C1(2)=-ALFA*N*DT
      DO 30 K=1,N
      I1=5*(K-1)+1
      I2=10*(K-1)+2
      A(I1+1,I2+1)=EPS
      A(I1+1,I2+2)=EPS
      A(I1+1,I2+9)=EPS
      B(I1+1)=R1*DT

      A(I1+2,I2+2)=1
      A(I1+2,I2+3)=1.0/RGAM
      A(I1+2,I2+4)=1
      B(I1+2)=G(K)

      A(I1+3,I2+6)=1.0/DEL
      A(I1+3,I2+7)=1.0/DEL
      B(I1+3)=R2*DT

      A(I1+4,I2+8)=1
      B(I1+4)=UH

      A(I1+5,I2+8)=-1
      B(I1+5)=-UL
   30 CONTINUE
```

```
            M4=5*N+1

            TEMU1=1.0/RMEU
            N1=N-1
            DO 40 J=1,N1
            TMEU2=1.0/RMEU
            TMEU1=TMEU1*RMEU
            J1=2*(J-1)
            A(M4+J1+1,1)=TMEU1
            A(M4+J1+1,2)=-1.0
            A(M4+J1+2,1)=-TMEU1
            B(M4+J1+1)=0
            B(M4+J1+2)=0
            DO 50 K1=1,J
            TMEU2=TMEU2*RMEU
            K=J-K1+1
            K2=10*(K-1)+2
            A(M4+J1+1,K2+1)=EPS*TMEU2
            IF(K.NE.J) A(M4+J1+2,K2+1)=-EPS*TMEU2
            A(M4+J1+1,K2+2)=EPS*TMEU2
            IF(K.NE.J) A(M4+J1+2,K2+2)=-EPS*TMEU2
            A(M4+J1+1,K2+9)=EPS*TMEU2
            IF(K.NE.J) A(M4+J1+2,K2+9)=-EPS*TMEU2
            A(M4+J1+1,K2+6)=-TMEU2/DEL
            A(M4+J1+2,K2+6)=TMEU2/DEL
            A(M4+J1+1,K2+7)=-TMEU2/DEL
            A(M4+J1+2,K2+7)=TMEU2/DEL
      50    CONTINUE
      40    CONTINUE

     C      M2 EQUALITY CONSTRAINTS

            DO 60 K=1,N
            I2=10*(K-1)+2
            A(M1+K,I2+4)=1
            A(M1+K,I2+5)=RGAM
            A(M1+K,I2+6)=1
            A(M1+K,I2+8)=-1
            A(M1+N+K,I2+9)=1
            A(M1+N+K,I2+10)=1.0/RGAM
            A(M1+N+K,I2+8)=-BETA
      60    CONTINUE

            A(M1+2*N+1,1)=TMEU2*RMEU-1.0
            C(1)=-1.0E-8
            TMEU1=1.0/RMEU
            DO 70 K1=1,N
            TMEU1=TMEU1*RMEU
            K=N-K1+1
            I2=10*(K-1)+2
            A(M1+2*N+1,I2+1)=EPS*TMEU1
            A(M1+2*N+1,I2+2)=EPS*TMEU1
            A(M1+2*N+1,I2+9)=EPS*TMEU1
            A(M1+2*N+1,I2+6)=-TMEU1/DEL
            A(M1+2*N+1,I2+7)=-TMEU1/DEL
            A(M1+2*N+2,I2+8)=1
```

```
                  C(I2+1)=-Q(K)
                  C(I2+2)=-R(K)
                  C(I2+3)=P(K)-R(K)/RGAM
                  C(I2+4)=-R(K)
                  C(I2+5)=-Q(K)
                  C(I2+7)=P(K)
                  C(I2+10)=P(K)

                  C1(I2+1)=Q(K)
                  C1(I2+3)=-P(K)
                  C1(I2+5)=Q(K)
                  C1(I2+7)=-P(K)
                  C1(I2+10)=-P(K)

         70       CONTINUE
                  B(M1+2*N+2)=UT
                  RETURN
                  END
```

```
    SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3   FRMLP3

VARIABLES      SN  TYPE          RELOCATION
    0   A          REAL     ARRAY     F.P.         0   ALFA     REAL                 F.P.
    0   B          REAL     ARRAY     F.P.         0   BETA     REAL                 F.P.
    0   C          REAL     ARRAY     F.P.         0   C1       REAL     ARRAY       F.P.
    0   DEL        REAL               F.P.         0   DT       REAL                 F.P.
    0   EPS        REAL               F.P.         0   G        REAL     ARRAY       F.P.
  474   I          INTEGER                       477   I1       INTEGER
  500   I2         INTEGER                       475   J        INTEGER
  506   J1         INTEGER                       476   K        INTEGER
  507   K1         INTEGER                       510   K2       INTEGER
    0   MD1        INTEGER            F.P.         0   MD2      INTEGER              F.P.
    0   MD3        INTEGER            F.P.         0   M1       INTEGER              F.P.
    0   M2         INTEGER            F.P.       473   M3       INTEGER
  501   M4         INTEGER                         0   N        INTEGER              F.P.
    0   NP         INTEGER            F.P.       503   N1       INTEGER
    0   P          REAL     ARRAY     F.P.         0   Q        REAL     ARRAY       F.P.
    0   R          REAL     ARRAY     F.P.         0   RGAM     REAL                 F.P.
    0   RMEU       REAL               F.P.         0   R1       REAL                 F.P.
    0   R2         REAL               F.P.       502   TEMU1    REAL
  505   TMEU1      REAL                          504   TMEU2    REAL
    0   UH         REAL               F.P.         0   UL       REAL                 F.P.
    0   UT         REAL               F.P.

STATEMENT LABELS
    0   2                   0   3                          0   30
    0   40                  0   50                         0   60
    0   70
```

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES	
21	2	I	19 23	15B		NOT INNER
30	2	J	21 23	2B	OPT	
43	3	J	24 27	2B	OPT	
125	30	K	35 57	32B	OPT	
166	40	J	62 86	74B		NOT INNER
216	50	K1	71 85	40B	OPT	
327	60	K	90 99	16B	OPT	
406	70	K1	104 129	33B	OPT	

STATISTICS
PROGRAM LENGTH 563B 371
52000B CM USED

```
      SUBROUTINE OUT(ICHW,IOPT,PSOL,N,SMAX,IER,MD3)
      REAL PSOL(MD3)
C
C     THIS ROUTINE OUTPUTS THE RESULTS OF THE OPTIMUM SPOT PRICING
C     PROCEDURE.
C
      IF((IOPT.EQ.1).OR.(IOPT.EQ.2)) ISOE=7
      IF((IOPT.EQ.3).OR.(IOPT.EQ.4)) ISOE=8
      IF((IOPT.EQ.5).OR.(IOPT.EQ.6)) ISOE=10
      PRINT (ICHW,5)
    5 FORMAT("1")
      PRINT (ICHW,7) PSOL(1),SMAX,IER
    7 FORMAT(10X,"XO=",F8.2,8X,"REVENUE=",F10.2,8X,"ERROR=",I5//)
      PRINT (ICHW,12) (I,I=1,ISOE)
   12 FORMAT(8X,"    K     ",10(I5,5X))
      PRINT (ICHW,14)
   14 FORMAT(4X,"PERIOD")
      DO 10 K=1,N
      I2=ISOE*(K-1)+2
      PRINT (ICHW,15) K,(PSOL(I2+I),I=1,ISOE)
   15 FORMAT(7X,I3,5X,10(F8.2,2X))
   10 CONTINUE
      RETURN
      END
```

```
      SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  OUT

VARIABLES      SN  TYPE          RELOCATION
  147  I           INTEGER                          0  ICHW        INTEGER                F.P.
    0  IER         INTEGER           F.P.           0  IOPT        INTEGER                F.P.
  146  ISOE        INTEGER                        151  I2          INTEGER
  150  K           INTEGER                          0  MD3         INTEGER                F.P.
    0  N           INTEGER           F.P.           0  PSOL        REAL        ARRAY      F.P.
    0  SMAX        REAL              F.P.

STATEMENT LABELS
   75  5       FMT                       105  7       FMT                       0  10
  122  12      FMT                       131  14      FMT                     143  15

LOOPS  LABEL    INDEX    FROM-TO    LENGTH    PROPERTIES
   37           I         17 17        4B              EXT REFS
   47  10       K         21 25       22B              EXT REFS  NOT INNER
   55           I         23 23       10B              EXT REFS

STATISTICS
  PROGRAM LENGTH               155B      109
        52000B CM USED
```

```
              SUBROUTINE PRSCH
             +(ICHW,IOPT,P,Q,R,U,PSOL,SCH,N,SMAX,BETA,EPS,DEL,RGAM,RMEU,MD1,MD3)

              REAL P(MD1),Q(MD1),R(MD1),U(MD1),PSOL(MD3)
              REAL SCH(MD1)

        C
        C     THIS ROUTINE PRINTS OUT THE OPTIMAL OPERATING SCHEDULE
        C

              PRINT (ICHW,5)
          5   FORMAT("1")
              IF((IOPT.EQ.1).OR.(IOPT.EQ.3).OR.(IOPT.EQ.5)) PRINT (ICHW,10)
              IF((IOPT.EQ.2).OR.(IOPT.EQ.4).OR.(IOPT.EQ.6)) PRINT (ICHW,11)
         10   FORMAT(5X,"** OPTIMAL SCHEDULE FOR THE PRODUCER **"//)
         11   FORMAT(5X,"** OPTIMAL SCHEDULE FOR THE UTILITY **"//)
              PRINT (ICHW,12) PSOL(1)
         12   FORMAT(5X,"INITIAL STORAGE ENERGY LEVEL=",F8.2/)
              PRINT (ICHW,14) PSOL(2)
         14   FORMAT(5X,"OPTIMUM STORAGE CAPACITY=",F8.2//)
              PRINT (ICHW,15)
         15   FORMAT
             +(7X,"PRODUCE",3X,"DEP-GEN",6X,"USE",7X,"SELL",6X," BUY",5X,"STORE"
             + ,6X,"LEVEL",5X,"LOSS",8X,"PROFIT")
              PRINT (ICHW,17)
         17   FORMAT(2X,"PERIOD")

              IF((IOPT.EQ.1).OR.(IOPT.EQ.2)) ISOE=7
              IF((IOPT.EQ.3).OR.(IOPT.EQ.4)) ISOE=8
              IF((IOPT.EQ.5).OR.(IOPT.EQ.6)) ISOE=10
              IF((ISOE.EQ.7).OR.(ISOE.EQ.8)) BETA=0.

              STORED=PSOL(1)
              DO 20 K=1,N
              I2=ISOE*(K-1)+2
              PRODUCE=PSOL(I2+2)+PSOL(I2+3)/RGAM+PSOL(I2+4)
              USE=PSOL(I2+4)+RGAM*PSOL(I2+5)+PSOL(I2+6)
              COGEN=BETA*USE
              IF((IOPT.EQ.3).OR.(IOPT.EQ.4)) U(K)=USE
              IF((IOPT.EQ.5).OR.(IOPT.EQ.6)) U(K)=USE
              STR=0
              DSC=0
              IF((IOPT.EQ.5).OR.(IOPT.EQ.6)) STR=PSOL(I2+9)
              IF((IOPT.EQ.5).OR.(IOPT.EQ.6)) DSC=PSOL(I2+10)
              SELL=PSOL(I2+3)+PSOL(I2+7)+DSC
              BUY=PSOL(I2+1)+PSOL(I2+5)
              SCH(K)=SELL-BUY
              STORE=
             +EPS*(PSOL(I2+1)+PSOL(I2+2)+STR)-(PSOL(I2+6)+PSOL(I2+7))/DEL
              STORED=STORED*RMEU+STORE
              RLOSS=(1-EPS)*(PSOL(I2+1)+PSOL(I2+2)+STR)
             + +(1-DEL)*(PSOL(I2+6)+PSOL(I2+7))/DEL
             + +(1-RGAM)*(PSOL(I2+3)/RGAM+PSOL(I2+5))
              PROFIT=SELL*P(K)-BUY*Q(K)-PRODUCE*R(K)
              PRINT (ICHW,25)
             + K,PRODUCE,COGEN,USE,SELL,BUY,STORE,STORED,RLOSS,PROFIT
         25   FORMAT(2X,I2,2X,8(F8.2,2X),F12.2)
```

```
           20   CONTINUE
                IF (SMAX.GE.0.) PRINT (ICHW,30) SMAX
                IF (SMAX.LE.0.) PRINT (ICHW,31) -SMAX
           30   FORMAT(/5X,"TOTAL REVENUE FOR SPPF=",F10.2/)
           31   FORMAT(/5X,"TOTAL COST FOR SPPF=",F10.2/)
                RETURN
                END
```

```
     SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  PRSCH

VARIABLES       SN  TYPE           RELOCATION
    0  BETA        REAL                  F.P.         372  BUY       REAL
  366  COGEN       REAL                                 0  DEL       REAL                 F.P.
  370  DSC         REAL                                 0  EPS       REAL                 F.P.
    0  ICHW        INTEGER               F.P.           0  IOPT      INTEGER              F.P.
  360  ISOE        INTEGER                            363  I2        INTEGER
  362  K           INTEGER                              0  MD1       INTEGER              F.P.
    0  MD3         INTEGER               F.P.           0  N         INTEGER              F.P.
    0  P           REAL        ARRAY     F.P.         364  PRODUCE   REAL
  375  PROFIT      REAL                                 0  PSOL      REAL       ARRAY     F.P.
    0  Q           REAL        ARRAY     F.P.           0  R         REAL       ARRAY     F.P.
    0  RGAM        REAL                  F.P.         374  RLOSS     REAL
    0  RMEU        REAL                  F.P.           0  SCH       REAL       ARRAY     F.P.
  371  SELL        REAL                                 0  SMAX      REAL                 F.P.
  373  STORE       REAL                               361  STORED    REAL
  367  STR         REAL                                 0  U         REAL       ARRAY     F.P.
  365  USE         REAL

STATEMENT LABELS
  220  5       FMT                      230  10     FMT                        236  11
  250  12      FMT                      262  14     FMT                        272  15
  311  17      FMT                        0  20                                331  25
  345  30      FMT                      352  31     FMT

LOOPS   LABEL    INDEX    FROM-TO    LENGTH    PROPERTIES
   72   20       K          34 58     110B               EXT REFS

STATISTICS
  PROGRAM LENGTH               424B      276
      52000B CM USED
```

```
      SUBROUTINE PLTSQ(XL,YL,FACT,SMAX,ICOMM1,ICOMM2,ICOMM3)
C
C     THIS ROUTINE PLOTS A SQUARE AND PRINTS THE COMMENT.
C
      CALL FACTOR(FACT)
      CALL PLOT(0.,0.,-3)
      CALL PLOT(0.,YL,-2)
      CALL PLOT(XL,0.,-2)
      CALL PLOT(0.,-YL,-2)
      CALL PLOT(-XL,0.,-2)
      CALL SYMBOL(1.,YL-1.,.5,ICOMM1,0.,10)
      CALL SYMBOL(5.5,YL-1.,.5,ICOMM2,0.,10)
      CALL SYMBOL(10.5,YL-1.,.5,ICOMM3,0.,10)
      CALL SYMBOL(1.,YL-2.,.5,"PROFIT = $",0.,10)
      CALL NUMBER(6.,YL-2.,.5,SMAX,0.,2)
      RETURN
      END
```

```
     SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  PLTSQ

VARIABLES     SN  TYPE          RELOCATION
    0  FACT       REAL                F.P.        0  ICOMM1    INTEGER         F.P.
    0  ICOMM2     INTEGER             F.P.        0  ICOMM3    INTEGER         F.P.
    0  SMAX       REAL                F.P.        0  XL        REAL            F.P.
    0  YL         REAL                F.P.

EXTERNALS            TYPE   ARGS
       FACTOR                1                       NUMBER              6
       PLOT                  3                       SYMBOL              6

STATISTICS
  PROGRAM LENGTH                172B      122
        52000B CM USED
```

```
      SUBROUTINE PLT1(A,OX,OY,DT,N,FAC,IX,JY,I1,J1,MD1)

      REAL A(MD1),XA(512),YA(512)
      REAL IX(2),JY(2)

C
C     THIS ROUTINE PLOTS THE NUMBERS IN THE ARRAY A.
C

      CALL PLOT(OX,OY,-3)
      CALL PLOT(0.,-.5,3)
      CALL FACTOR(FAC)

      N1=N-1
      N2=2*N
      DTC=0.
      XA(1)=0.
      YA(1)=A(1)
      DO 10 I=1,N1
      DTC=DTC+DT
      XA(2*I)=DTC
      XA(2*I+1)=DTC
      YA(2*I)=A(I)
      YA(2*I+1)=A(I+1)
   10 CONTINUE
      XA(N2)=N*DT
      YA(N2)=A(N)

      CALL SCALE(XA,6.5,N2,1)
      CALL SCALE(YA,4.5,N2,1)
      CALL AXIS(0.,0.,IX,-I1,6.5,0.,XA(N2+1),XA(N2+2))
      CALL AXIS(0.,0.,JY,J1,4.5,90.,YA(N2+1),YA(N2+2))
      CALL LINE(XA,YA,N2,1,0,0)

      RETURN
      END
```

SYMPOLIC REFERENCE MAP (R=1)

ENTRY POINTS
3 PLT1

VARIABLES		SN	TYPE	RELOCATION							
0	A		REAL	ARRAY	F.P.	0	DT	REAL		F.P.
163	DTC		REAL			0	FAC	REAL		F.P.
164	I		INTEGER			0	IX	REAL	ARRAY	F.P.
0	I1		INTEGER		F.P.	0	JY	REAL	ARRAY	F.P.
0	J1		INTEGER		F.P.	0	MD1	INTEGER		F.P.
0	N		INTEGER		F.P.	161	N1	INTEGER		
162	N2		INTEGER			0	OX	REAL		F.P.
0	OY		REAL		F.P.	165	XA	REAL	ARRAY	
1165	YA		REAL	ARRAY						

```
      SUBROUTINE PLT1       74/835   OPT=1                              FTN 4.8+628        85/06

EXTERNALS          TYPE   ARGS
      AXIS                  8                         FACTOR               1
      LINE                  6                         PLOT                 3
      SCALE                 4

STATEMENT LABELS
    0  10

LOOPS  LABEL     INDEX      FROM-TO     LENGTH     PROPERTIES
   33  10        I            19 25         6B         OPT

STATISTICS
  PROGRAM LENGTH              2167B    1143
          52000B CM USED
```

DATE: 11 JUN 85 AT 16:50:09

DEPARTMENT: DFAULT:JDL*

JOB ID: 908 REPORT NO. 25

FILE ID:

INPUT PROCESSING TIME: 00:00:19

OUTPUT PROCESSING TIME: 00:00:24

REPORT COMPLETION CODE: 50

PAGES TO BIN:	31		
PAGES TO TRAY:	0		
PAPER PATH HOLES:	10		
LINES PRINTED:	1334	GRAPHIC PAGES PRINTED:	1
ONLINE IDLE (SEC):	0	GRAPHIC EXCEPTION CODE:	0
BLOCKS READ:	0	GRAPHIC IMAGES READ:	0
BLOCKS SKIPPED:	0	GRAPHIC IMAGES MOVED:	0
RECORDS READ:	1339		
DJDE RECORDS READ:	9		
MAXIMUM COPY COUNT:	1		
OVERPRINTS:	0		
COLLATE:	YES		
SF/MF:	MULTI		
SIMPLEX/DUPLEX:	BOTH		

JDE,JDL USED: DFLT,DFAULT

ACCTINFO:

INITIAL FONT LIST: L0112B

(DJDE MODIFIED)

INITIAL FORM LIST: BANNER

(DJDE MODIFIED)

INITIAL CME LIST: -NONE

APPENDIX 7

PROGRAM TPRX1

LISTING

```
      PROGRAM TPRX1 (INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,TAPE2,TAPE3)
C
C      PROGRAMMER : HASSAN GHOUDJEHBAKLOU
C      DATE       : 5/12/85
C
C      PURPOSE - THIS PROGRAM OPTIMIZES THE PRICES BY SOLVING
C                A LINEAR PROGRAM OF THE FORM:
C
C                 MIN  C*X
C                 S.T. A*X >= B
C
       DIMENSION A(100,150),B(100),C(150),X(150),Y(100)
       DIMENSION B1(100,100),MBASIS(100),CB(100),C1(150)
       DIMENSION ROW(150),COL(100)
       DIMENSION MBE(250),X1(250)
       DIMENSION PL(24),QU(24)

       DIMENSION A2(100,150),B2(100),C2(150)
       DIMENSION B3(100)

       REAL P(24),Q(24),R(24),G(24),U(24)
       REAL XL(24),XU(24)
       INTEGER KOPT(24)

       COMMON /ICH/ICHR,ICHW,ICH2,ICH3
       ICH2=2
       REWIND ICH2
       ICH3=3
       REWIND ICH3
       ICHR=5
       REWIND ICHR
       ICHW=6
       MD0=24
       MD1=100
       MD2=150
       MD3=250

       CALL LININ
     + (IOPT,JOPT,A,B,C,A2,B2,C2,P,Q,R,G,U,
     + KOPT,XL,XU,PL,QU,N,M1,N1,K1,K2,
     + DT,R1,R2,S,DECI,BETA,EPS,DEL,RGAM,RMEU,
     + MD0,MD1,MD2)
C      DO 5 I=1,M1
C      MBASIS(I)=I+N1
C5     CONTINUE

       IF (JOPT.EQ.1) CALL LP1
     + (ICH2,A,B,C,X,Y,B1,MBASIS,CB,C1,ROW,COL,M1,N1,MD1,MD2)

       IF (JOPT.EQ.2) CALL LP2
     + (ICH2,A,B,C,X,Y,B1,MBASIS,CB,C1,ROW,COL,M1,N1,
     + KOPT,N,K1,K2,MD0,MD1,MD2)

       CALL SALL (B,CB,X,B1,MBASIS,M1,N1,MD1,MD2)
       CALL PR (ICH2,B,B1,MBASIS,M1,MD1)
       CALL EXPAND (B,X1,MBASIS,MBE,M1,N1,MD1,MD3)
       CALL FLP2 (A,B,C,C1,X1,B1,MBASIS,MBE,PL,QU,A2,B2,B3,C2,
```

```
     + M1,N1,N,M2,N2,MD0,MD1,MD2,MD3)
      CALL LP1
     + (ICH2,A2,B2,C2,X,Y,B1,MBASIS,CB,C1,ROW,COL,M2,N2,MD1,MD2)
      CALL PR1 (ICHW,B2,B1,MBASIS,N,MD1)
      CALL LP1
     + (ICH2,A2,B3,C2,X,Y,B1,MBASIS,CB,C1,ROW,COL,M2,N2,MD1,MD2)
      CALL PR1 (ICHW,B3,B1,MBASIS,N,MD1)
      STOP
      END
```

```
SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
 10274  TPRX1

VARIABLES       SN  TYPE          RELOCATION
 10657  A           REAL       ARRAY                    74707  A2       REAL       ARRAY
 46107  B           REAL       ARRAY                    10650  BETA     REAL
 47073  B1          REAL       ARRAY                   132137  B2       REAL       ARRAY
132531  B3          REAL       ARRAY                    46253  C        REAL       ARRAY
 72657  CB          REAL       ARRAY                    73477  COL      REAL       ARRAY
 73023  C1          REAL       ARRAY                   132303  C2       REAL       ARRAY
 10647  DECI        REAL                                10652  DEL      REAL
 10643  DT          REAL                                10651  EPS      REAL
133005  G           REAL       ARRAY                        0  ICHR     INTEGER               ICH
     1  ICHW        INTEGER              ICH                2  ICH2     INTEGER               ICH
     3  ICH3        INTEGER              ICH            10634  IOPT     INTEGER
 10635  JOPT        INTEGER                            133145  KOPT     INTEGER    ARRAY
 10641  K1          INTEGER                             10642  K2       INTEGER
 72513  MBASIS      INTEGER    ARRAY                    73643  MBE      INTEGER    ARRAY
 10630  MD0         INTEGER                             10631  MD1      INTEGER
 10632  MD2         INTEGER                             10633  MD3      INTEGER
 10637  M1          INTEGER                             10655  M2       INTEGER
 10636  N           INTEGER                             10640  N1       INTEGER
 10656  N2          INTEGER                            132675  P        REAL       ARRAY
 74627  PL          REAL       ARRAY                   132725  Q        REAL       ARRAY
 74657  QU          REAL       ARRAY                   132755  R        REAL       ARRAY
 10653  RGAM        REAL                                10654  RMEU     REAL
 73251  ROW         REAL       ARRAY                    10644  R1       REAL
 10645  R2          REAL                                10646  S        REAL
133035  U           REAL       ARRAY                    46501  X        REAL       ARRAY
133065  XL          REAL       ARRAY                   133115  XU       REAL       ARRAY
 74235  X1          REAL       ARRAY                    46727  Y        REAL       ARRAY

FILE NAMES        MODE
    0  INPUT                 2054  OUTPUT                4130  TAPE2                62
    0  TAPE5                 2054  TAPE6

EXTERNALS           TYPE   ARGS
       EXPAND                8                          FLP2               23
       LININ                36                          LP1                16
       LP2                  21                          PR                  6
       PR1                   6                          SALL                9
```

```
COMMON BLOCKS   LENGTH
      ICH            4

STATISTICS
  PROGRAM LENGTH              123302B    42690
  BUFFER LENGTH                 7673B     4027
  CM LABELED COMMON LENGTH         4B        4
          52000B CM USED
```

```
      SUBROUTINE LP1
     + (ICHW,A,B,C,X,Y,B1,MBASIS,CB,C1,ROW,COL,M1,N1,MD1,MD2)
C
C     PURPOSE - MAIN DRIVER ROUTINE OF THE DUAL SIMPLEX PROCEDURE.
C
      DIMENSION A(MD1,MD2),B(MD1),C(MD2),X(MD2),Y(MD1)
      DIMENSION B1(MD1,MD1),MBASIS(MD1),CB(MD1),C1(MD2)
      DIMENSION ROW(MD2),COL(MD1)


      CALL INIT1 (B,C,B1,MBASIS,CB,C1,M1,N1,MD1,MD2)

      MN=M1+N1
    1 CONTINUE

      CALL BMIN (ICHW,B,IR,M1,MD1)

      IF (IR.EQ.10000) GO TO 2
      DO 10 J=1,N1
      ROW(J)=0.0
      DO 10 I=1,M1
      ROW(J)=ROW(J)-B1(IR,I)*A(I,J)
   10 CONTINUE
      DO 12 J=1,M1
      ROW(J+N1)=B1(IR,J)
   12 CONTINUE

      CALL SORT (ICHW,C1,ROW,JC,MN,MD2)

      IF (JC.EQ.10000) RETURN
      IF (JC.LE.N1) GO TO 15
      DO 14 I=1,M1
      COL(I)=B1(I,JC-N1)
   14 CONTINUE
      GO TO 22
   15 CONTINUE
      DO 20 I=1,M1
      COL(I)=0.0
      DO 20 J=1,M1
      COL(I)=COL(I)-B1(I,J)*A(J,JC)
   20 CONTINUE
   22 CONTINUE

      CALL PIVOT (A,B,C,B1,MBASIS,CB,C1,ROW,COL,IR,JC,M1,N1,MD1,MD2)

      GO TO 1
    2 CONTINUE
      CALL SALL (B,CB,X,B1,MBASIS,M1,N1,MD1,MD2)
      CALL PR (ICHW,B,B1,MBASIS,M1,MD1)
    3 CONTINUE
      CALL C1MIN (ICHW,C1,JC,MN,MD2)
      IF (JC.EQ.10000) RETURN
      IF (JC.GT.N1) GO TO 40
      DO 35 I=1,M1
      COL(I)=0.0
      DO 35 K=1,M1
      COL(I)=COL(I)-B1(I,K)*A(K,JC)
```

```
        35     CONTINUE
               GO TO 50
        40     CONTINUE
               DO 45 I=1,M1
               COL(I)=B1(I,JC-N1)
        45     CONTINUE
        50     CONTINUE
               CALL SORT2 (ICHW,B,COL,IR,M1,MD1)
               IF (IR.EQ.10000) RETURN
               CALL PIVOT (A,B,C,B1,MBASIS,CB,C1,ROW,COL,IR,JC,M1,N1,MD1,MD2)
               GO TO 3
               END
```

```
     SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  LP1

VARIABLES      SN  TYPE            RELOCATION
    0  A            REAL      ARRAY     F.P.              0  B       REAL      ARRAY     F.P.
    0  B1           REAL      ARRAY     F.P.              0  C       REAL      ARRAY     F.P.
    0  CB           REAL      ARRAY     F.P.              0  COL     REAL      ARRAY     F.P.
    0  C1           REAL      ARRAY     F.P.            454  I       INTEGER
    0  ICHW         INTEGER             F.P.            452  IR      INTEGER
  453  J            INTEGER                             455  JC      INTEGER
  456  K            INTEGER                               0  MBASIS  INTEGER   ARRAY     F.P.
    0  MD1          INTEGER             F.P.              0  MD2     INTEGER             F.P.
  451  MN           INTEGER                               0  M1      INTEGER             F.P.
    0  N1           INTEGER             F.P.              0  ROW     REAL      ARRAY     F.P.
    0  X            REAL      ARRAY     F.P.              0  Y       REAL      ARRAY     F.P.

EXTERNALS             TYPE    ARGS
       BMIN                     5                            C1MIN            5
       INIT1                   10                            PIVOT           15
       PR                       6                            SALL             9
       SORT                     6                            SORT2            6

STATEMENT LABELS
   33  1                                201  2                                    232  3
    0  10                                 0  12                                     0  14
  131  15                                 0  20                                   153  22
    0  35                               266  40                                     0  45
  302  50

LOOPS  LABEL     INDEX     FROM-TO     LENGTH     PROPERTIES
   45  10        J           19 23       21B                 NOT INNER
   57  10        I           21 23        3B          OPT
   77  12        J           24 26        2B          OPT
  126  14        I           32 34        2B          OPT
  132  20        I           37 41       21B                 NOT INNER
  144  20        J           39 41        3B          OPT
```

```
LOOPS  LABEL    INDEX     FROM-TO     LENGTH    PROPERTIES
  244  35       I           54 58        21B              NOT INNER
  256  35       K           56 58         3B        OPT
  277  45       I           62 64         2B        OPT

STATISTICS
  PROGRAM LENGTH                  502B      322
          52000B CM USED
```

```
      SUBROUTINE LP2
     + (ICHW,A,B,C,X,Y,B1,MBASIS,CB,C1,ROW,COL,M1,N1,
     + KOPT,N,K1,K2,MD0,MD1,MD2)
C
C     PURPOSE - MAIN DRIVER ROUTINE OF THE DUAL SIMPLEX PROCEDURE.
C
      DIMENSION A(MD1,MD2),B(MD1),C(MD2),X(MD2),Y(MD1)
      DIMENSION B1(MD1,MD1),MBASIS(MD1),CB(MD1),C1(MD2)
      DIMENSION ROW(MD2),COL(MD1)

      INTEGER KOPT(MD0)


      CALL INIT2 (B,C,B1,MBASIS,CB,C1,M1,N1,KOPT,N,K1,K2,MD0,MD1,MD2)

      MN=M1+N1
    1 CONTINUE

      CALL BMIN (ICHW,B,IR,M1,MD1)

      IF (IR.EQ.10000) GO TO 2
      DO 10 J=1,N1
      ROW(J)=0.0
      DO 10 I=1,M1
      ROW(J)=ROW(J)-B1(IR,I)*A(I,J)
   10 CONTINUE
      DO 12 J=1,M1
      ROW(J+N1)=B1(IR,J)
   12 CONTINUE

      CALL SORT (ICHW,C1,ROW,JC,MN,MD2)

      IF (JC.EQ.10000) RETURN
      IF (JC.LE.N1) GO TO 15
      DO 14 I=1,M1
      COL(I)=B1(I,JC-N1)
   14 CONTINUE
      GO TO 22
   15 CONTINUE
      DO 20 I=1,M1
      COL(I)=0.0
      DO 20 J=1,M1
      COL(I)=COL(I)-B1(I,J)*A(J,JC)
   20 CONTINUE
   22 CONTINUE

      CALL PIVOT (A,B,C,B1,MBASIS,CB,C1,ROW,COL,IR,JC,M1,N1,MD1,MD2)

      GO TO 1
    2 CONTINUE
      CALL SALL (B,CB,X,B1,MBASIS,M1,N1,MD1,MD2)
      CALL PR (ICHW,B,B1,MBASIS,M1,MD1)


    3 CONTINUE
      CALL C1MIN (ICHW,C1,JC,MN,MD2)
      IF (JC.EQ.10000) RETURN
```

```
                IF (JC.GT.N1) GO TO 40
                DO 35 I=1,M1
                COL(I)=0.0
                DO 35 K=1,M1
                COL(I)=COL(I)-B1(I,K)*A(K,JC)
        35      CONTINUE
                GO TO 50

        40      CONTINUE
                DO 45 I=1,M1
                COL(I)=B1(I,JC-N1)
        45      CONTINUE

        50      CONTINUE
                CALL SORT2 (ICHW,B,COL,IR,M1,MD1)
                IF (IR.EQ.10000) RETURN
                CALL PIVOT (A,B,C,B1,MBASIS,CB,C1,ROW,COL,IR,JC,M1,N1,MD1,MD2)
                GO TO 3
                END
```

SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
3 LP2

VARIABLES		SN TYPE		RELOCATION					
0	A	REAL	ARRAY	F.P.	0	B	REAL	ARRAY	F.P.
0	B1	REAL	ARRAY	F.P.	0	C	REAL	ARRAY	F.P.
0	CB	REAL	ARRAY	F.P.	0	COL	REAL	ARRAY	F.P.
0	C1	REAL	ARRAY	F.P.	471	I	INTEGER		
0	ICHW	INTEGER		F.P.	467	IR	INTEGER		
470	J	INTEGER			472	JC	INTEGER		
473	K	INTEGER			0	KOPT	INTEGER	ARRAY	F.P.
0	K1	INTEGER		F.P.	0	K2	INTEGER		F.P.
0	MBASIS	INTEGER	ARRAY	F.P.	0	MD0	INTEGER		F.P.
0	MD1	INTEGER		F.P.	0	MD2	INTEGER		F.P.
466	MN	INTEGER			0	M1	INTEGER		F.P.
0	N	INTEGER		F.P.	0	N1	INTEGER		F.P.
0	ROW	REAL	ARRAY	F.P.	0	X	REAL	ARRAY	F.P.
0	Y	REAL	ARRAY	F.P.					

EXTERNALS	TYPE	ARGS		
BMIN		5	C1MIN	5
INIT2		15	PIVOT	15
PR		6	SALL	9
SORT		6	SORT2	6

STATEMENT LABELS

43	1	211	2	242	3
0	10	0	12	0	14
141	15	0	20	163	22
0	35	276	40	0	45
312	50				

```
LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   55  10       J          22 26       21B               NOT INNER
   67  10       I          24 26        3B         OPT
  107  12       J          27 29        2B         OPT
  136  14       I          35 37        2B         OPT
  142  20       I          40 44       21B               NOT INNER
  154  20       J          42 44        3B         OPT
  254  35       I          59 63       21B               NOT INNER
  266  35       K          61 63        3B         OPT
  307  45       I          67 69        2B         OPT

STATISTICS
  PROGRAM LENGTH                 517B      335
          52000B CM USED
```

```
      SUBROUTINE INIT1 (B,C,B1,MBASIS,CB,C1,M1,N1,MD1,MD2)
C
C     PURPOSE - TO INITIALIZE THE SIMPLEX TABLE.
C
      DIMENSION B(MD1),C(MD2),B1(MD1,MD1),MBASIS(MD1),CB(MD1),C1(MD2)

      DO 10 I=1,M1
      B(I)=-B(I)
      MBASIS(I)=N1+I
      CB(I)=0.0
      DO 10 J=1,M1
      B1(I,J)=0.0
      IF (I.EQ.J) B1(I,J)=1.0
   10 CONTINUE
      DO 15 J=1,M1
      C(J+N1)=0.0
   15 CONTINUE
      MN=M1+N1

      DO 20 J=1,MN
      C1(J)=C(J)
   20 CONTINUE

      RETURN
      END
```

```
SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  INIT1

VARIABLES      SN  TYPE          RELOCATION
    0  B           REAL      ARRAY    F.P.           0  B1        REAL     ARRAY    F.P.
    0  C           REAL      ARRAY    F.P.           0  CB        REAL     ARRAY    F.P.
    0  C1          REAL      ARRAY    F.P.          60  I         INTEGER
   61  J           INTEGER                           0  MBASIS    INTEGER  ARRAY    F.P.
    0  MD1         INTEGER            F.P.           0  MD2       INTEGER           F.P.
   62  MN          INTEGER                           0  M1        INTEGER           F.P.
    0  N1          INTEGER            F.P.

STATEMENT LABELS
    0  10                        0  15                        0  20

LOOPS  LABEL   INDEX    FROM-TO   LENGTH   PROPERTIES
   11  10      I          7 14      22B             NOT INNER
   22  10      J         11 14       5B       OPT
   40  15      J         15 17       2B       OPT
   52  20      J         20 22       2B       OPT

STATISTICS
  PROGRAM LENGTH               73B       59
        52000B CM USED
```

```
      SUBROUTINE INIT2
     + (B,C,B1,MBASIS,CB,C1,M1,N1,KOPT,N,K1,K2,MD0,MD1,MD2)
C
C     PURPOSE - TO INITIALIZE THE SIMPLEX TABLE.
C
      DIMENSION B(MD1),C(MD2),B1(MD1,MD1),MBASIS(MD1),CB(MD1),C1(MD2)
      INTEGER KOPT(MD0)

      DO 10 I=1,M1
      B(I)=-B(I)
      MBASIS(I)=N1+I
      CB(I)=0.0
      DO 10 J=1,M1
      B1(I,J)=0.0
      IF (I.EQ.J) B1(I,J)=1.0
   10 CONTINUE
      DO 15 J=1,M1
      C(J+N1)=0.0
   15 CONTINUE
      MN=M1+N1

      DO 20 J=1,MN
      C1(J)=C(J)
   20 CONTINUE

      BIGM=10.
      DO 30 I=1,N
      IF(KOPT(I).EQ.0) GO TO 30
      CB(K1+I-1)=-BIGM
      C(N1+K1+I-1)=-BIGM
      CB(K1+N+I-1)=-BIGM
      C(N1+K1+N+I-1)=-BIGM
   30 CONTINUE
      RETURN
      END
```

SYMBOLIC REFERENCE MAP (R=1)

```
ENTRY POINTS
    3  INIT2

VARIABLES      SN   TYPE           RELOCATION
    0  B              REAL        ARRAY     F.P.          110  BIGM       REAL
    0  B1             REAL        ARRAY     F.P.            0  C          REAL       ARRAY     F.P.
    0  CB             REAL        ARRAY     F.P.            0  C1         REAL       ARRAY     F.P.
  105  I              INTEGER                             106  J          INTEGER
    0  KOPT           INTEGER     ARRAY     F.P.            0  K1         INTEGER              F.P.
    0  K2             INTEGER    *UNUSED    F.P.            0  MBASIS     INTEGER    ARRAY     F.P.
    0  MD0            INTEGER               F.P.            0  MD1        INTEGER              F.P.
    0  MD2            INTEGER               F.P.          107  MN         INTEGER
    0  M1             INTEGER               F.P.            0  N          INTEGER              F.P.
    0  N1             INTEGER               F.P.
```

```
STATEMENT LABELS
    0  10                                    0  15                                       0  20
   76  30

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   11  10       I           9 16       22B               NOT INNER
   22  10       J          13 16        5B         OPT
   40  15       J          17 19        2B         OPT
   52  20       J          22 24        2B         OPT
   73  30       I          27 33        5B         OPT

STATISTICS
  PROGRAM LENGTH              121B       81
          52000B CM USED
```

```
            SUBROUTINE BMIN (ICHW,B,IR,M1,MD1)
      C
      C     PURPOSE - TO LOCATE THE SMALLEST ENTRY OF VECTOR B.
      C
            DIMENSION B(MD1)

      C     NOTE: FIRST ROW SHOULD NOT BE A CONFINED CONSTRAINT.
      C
            EPS1=-1.0E-7
            T=B(1)
            IR=1
            DO 10 I=1,M1
            IF (B(I).GE.T) GO TO 10
            IR=I
            T=B(I)
       10   CONTINUE
            IF (T.LT.EPS1) RETURN
            PRINT (ICHW,15)
       15   FORMAT ("1"/5X,"BASIC FEASIBLE SOLUTION")
            IR=10000
            RETURN
            END
```

```
       SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  BMIN

VARIABLES      SN  TYPE            RELOCATION
    0  B           REAL        ARRAY     F.P.          43  EPS1      REAL
   45  I           INTEGER                              0  ICHW      INTEGER             F.P.
    0  IR          INTEGER               F.P.           0  MD1       INTEGER             F.P.
    0  M1          INTEGER               F.P.          44  T         REAL

STATEMENT LABELS
   21  10                                     34  15       FMT

LOOPS  LABEL     INDEX      FROM-TO    LENGTH    PROPERTIES
   16  10        I            12 16        4B        OPT

STATISTICS
  PROGRAM LENGTH                  50B       40
        52000B CM USED
```

```
              SUBROUTINE SORT (ICHW,C1,ROW,JC,N1,MD2)
      C
      C       PURPOSE - TO PERFORM MAXIMUM RATIO RULE.
      C
              DIMENSION C1(MD2),ROW(MD2)

              EPS1=-1.0E-7
              J=1
       1      IF (ROW(J).LT.EPS1) GO TO 2
              J=J+1
              IF (J.GT.N1) GO TO 6
              GO TO 1
       2      T1=C1(J)/ROW(J)
              JC=J
       3      J=J+1
              IF(J.GT.N1) GO TO 5
              IF (ROW(J).LT.EPS1) GO TO 4
              GO TO 3
       4      T2=C1(J)/ROW(J)
              IF (T2.LT.T1) GO TO 3
              JC=J
              T1=T2
              GO TO 3
       5      RETURN
      C
      C       FAILURE OF THE RATIO TEST INDICATES TERMINATION
      C       WITH NO SOLUTION.
      C
       6      PRINT (ICHW,7)
       7      FORMAT (5X,"PROBLEM HAS NO SOLUTION")
              JC=10000
              RETURN
              END
```

SYMBOLIC REFERENCE MAP (R=1)

```
ENTRY POINTS
    3  SORT

VARIABLES     SN  TYPE          RELOCATION
    0  C1         REAL      ARRAY     F.P.        62  EPS1      REAL
    0  ICHW       INTEGER             F.P.        63  J         INTEGER
    0  JC         INTEGER             F.P.         0  MD2       INTEGER               F.P.
    0  N1         INTEGER             F.P.         0  ROW       REAL       ARRAY      F.P.
   64  T1         REAL                            65  T2        REAL

STATEMENT LABELS
   10  1                        17  2                         24  3
   33  4                        43  5                         44  6
   53  7       FMT
```

```
STATISTICS
  PROGRAM LENGTH                 66B        54
        52000B CM USED
```

```
            SUBROUTINE PIVOT
     +      (A,B,C,B1,MBASIS,CB,C1,ROW,COL,IR,JC,M1,N1,MD1,MD2)
      C
      C     PURPOSE - TO PERFORM THE PIVOTING OPERATION.
      C
            DIMENSION A(MD1,MD2),B(MD1),C(MD2)
            DIMENSION B1(MD1,MD1),MBASIS(MD1),CB(MD1),C1(MD2)
            DIMENSION ROW(MD2),COL(MD1)

            DO 10 J=1,M1
            B1(IR,J)=B1(IR,J)/COL(IR)
         10 CONTINUE
            B(IR)=B(IR)/COL(IR)
            DO 20 I=1,M1
            IF (I EQ.IR) GO TO 20
            B(I)=B(I)-B(IR)*COL(I)
            DO 18 J=1,M1
            IF ((J+N1).EQ.JC) GO TO 18
            B1(I,J)=B1(I,J)-B1(IR,J)*COL(I)
         18 CONTINUE
         20 CONTINUE
            IF (JC.LE.N1) GO TO 25
            DO 22 I=1,M1
            B1(I,JC-N1)=0.0
         22 CONTINUE
            B1(IR,JC-N1)=1.0

         25 CONTINUE
            MBASIS(IR)=JC
            CB(IR)=C(JC)
            DO 30 J=1,M1
            ROW(J)=0.0
            DO 30 K=1,M1
            ROW(J)=ROW(J)+CB(K)*B1(K,J)
         30 CONTINUE
            DO 35 I=1,M1
            C1(I+N1)=C(I+N1)-ROW(I)
         35 CONTINUE
            DO 40 I=1,N1
            C1(I)=C(I)
            DO 40 K=1,M1
            C1(I)=C1(I)+ROW(K)*A(K,I)
      C
      C     NOTE: -A IS STORED
      C
         40 CONTINUE
      C     MN=M1+N1
      C     PRINT *," IR=",IR," JC=",JC
      C     PRINT (6,50) (C1(I),I=1,MN)
      C50   FORMAT (5(2X,F10.3))
            RETURN
            END
```

SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
3 PIVOT

VARIABLES SN TYPE RELOCATION

SN	NAME	TYPE		RELOCATION	SN	NAME	TYPE		RELOCATION
0	A	REAL	ARRAY	F.P.	0	B	REAL	ARRAY	F.P.
0	B1	REAL	ARRAY	F.P.	0	C	REAL	ARRAY	F.P.
0	CB	REAL	ARRAY	F.P.	0	COL	REAL	ARRAY	F.P.
0	C1	REAL	ARRAY	F.P.	173	I	INTEGER		
0	IR	INTEGER		F.P.	172	J	INTEGER		
0	JC	INTEGER		F.P.	174	K	INTEGER		
0	MBASIS	INTEGER	ARRAY	F.P.	0	MD1	INTEGER		F.P.
0	MD2	INTEGER		F.P.	0	M1	INTEGER		F.P.
0	N1	INTEGER		F.P.	0	ROW	REAL	ARRAY	F.P.

STATEMENT LABELS

0	10	53	18	56	20
0	22	105	25	0	30
0	35	0	40		

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES	
21	10	J	10 12	3B	OPT	
32	20	I	14 21	27B		NOT INNER
46	18	J	17 20	7B	OPT	
74	22	I	23 25	2B	OPT	
114	30	J	31 35	17B		NOT INNER
124	30	K	33 35	3B	OPT	
142	35	I	36 38	3B	OPT	
147	40	I	39 46	20B		NOT INNER
160	40	K	41 46	3B	OPT	

STATISTICS
PROGRAM LENGTH 226B 150
52000B CM USED

```
      SUBROUTINE PR (ICHW,B,B1,MBASIS,M1,MD1)
C
C     PURPOSE - TO PRINT OUT THE ANSWER.
C
      DIMENSION B(MD1),B1(MD1,MD1),MBASIS(MD1)

      DO 10 I=1,M1
      PRINT (ICHW,15) MBASIS(I),B(I)
 15   FORMAT (5X,"X(",I3,")=",F10.4)
 10   CONTINUE
C     PRINT (ICHW,*) " ** B1 **"
C     DO 20 I=1,M1
C     PRINT (ICHW,25) (B1(I,J),J=1,M1)
C25   FORMAT (5X,10(F8.3,2X))
C20   CONTINUE
      RETURN
      END
```

```
      SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3 PR

VARIABLES     SN  TYPE           RELOCATION
    0 B          REAL      ARRAY    F.P.           0  B1       REAL      ARRAY    F.P.
   32 I          INTEGER                           0  ICHW     INTEGER            F.P.
    0 MBASIS     INTEGER   ARRAY    F.P.           0  MD1      INTEGER            F.P.
    0 M1         INTEGER            F.P.

STATEMENT LABELS
    0 10                               26 15      FMT

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
    7  10       I            7 10       11B              EXT REFS

STATISTICS
  PROGRAM LENGTH                 37B       31
        52000B CM USED
```

```
              SUBROUTINE PR1 (ICHW,B,B1,MBASIS,N,MD1)
C
C             PURPOSE - TO PRINT OUT THE ANSWER.
C
              DIMENSION B(MD1),B1(MD1,MD1),MBASIS(MD1)

              PRINT (ICHW,5)
     5        FORMAT("1")
              PRINT (ICHW,10)
    10        FORMAT(9X,"K",4X,"P(K)",6X,"Q(K)")
              DO 20 I=1,N
              I1=2*(I-1)+1
              PRINT (ICHW,15) I,B(MBASIS(I1+1)),B(MBASIS(I1))
    15        FORMAT(5X,I5,2(F8.4,2X))
    20        CONTINUE
              RETURN
              END
```

```
    SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  PR1

VARIABLES       SN  TYPE            RELOCATION
    0  B             REAL       ARRAY     F.P.           0  B1         REAL       ARRAY     F.P.
   54  I             INTEGER                             0  ICHW       INTEGER              F.P.
   55  I1            INTEGER                             0  MBASIS     INTEGER    ARRAY     F.P.
    0  MD1           INTEGER              F.P.           0  N          INTEGER              F.P.

STATEMENT LABELS
   32  5       FMT                        37   10      FMT                         51   15
    0  20

LOOPS  LABEL     INDEX      FROM-TO     LENGTH     PROPERTIES
   13  20        I           11 15        13B                 EXT REFS

STATISTICS
  PROGRAM LENGTH                63B       51
        52000B CM USED
```

```
                SUBROUTINE SORT2 (ICHW,B,COL,IR,M1,MD1)
      C
      C         PURPOSE - TO SORT ACCORDING TO SIMPLEX METHOD.
      C
                DIMENSION B(MD1),COL(MD1)

                EPS1=1.0E-7
                I=1
       1        IF (COL(I).GT.EPS1) GO TO 2
                I=I+1
                IF (I.GT.M1) GO TO 6
                GO TO 1
       2        T1=B(I)/COL(I)
                IR=I
       3        I=I+1
                IF (I.GT.M1) GO TO 5
                IF (COL(I).GT.EPS1) GO TO 4
                GO TO 3
       4        T2=B(I)/COL(I)
                IF (T2.GE.T1) GO TO 3
                IR=I
                T1=T2
                GO TO 3
       5        RETURN
      C
      C         FAILURE OF THE RATIO TEST INDICATES TERMINATION
      C         WITH NO SOLUTION.
      C
       6        PRINT (ICHW,7)
       7        FORMAT (5X,"NO OPTIMAL SOLUTION EXISTS.")
                IR=10000
                RETURN
                END
```

```
      SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  SORT2

VARIABLES      SN  TYPE          RELOCATION
    0  B           REAL       ARRAY     F.P.            0  COL       REAL      ARRAY     F.P.
   61  EPS1        REAL                                62  I         INTEGER
    0  ICHW        INTEGER              F.P.            0  IR        INTEGER             F.P.
    0  MD1         INTEGER              F.P.            0  M1        INTEGER             F.P.
   63  T1          REAL                                64  T2        REAL

STATEMENT LABELS
   10  1                           17  2                                       24  3
   33  4                           43  5                                       44  6
   53  7       FMT
```

```
STATISTICS
  PROGRAM LENGTH                65B        53
          52000B CM USED
```

```
      SUBROUTINE SALL (B,CB,X,B1,MBASIS,M1,N1,MD1,MD2)
C     PURPOSE - TO SORT B, X, B1, AND MBASIS.
C
      DIMENSION B(MD1),CB(MD1),X(MD2),B1(MD1,MD1),MBASIS(MD1)

      MN=M1+N1
      DO 5 I=1,MN
       X(I)=0.0
    5 CONTINUE
      DO 20 I=1,M1
      DO 15 J=I,M1
      IF (MBASIS(J).GE.MBASIS(I)) GO TO 15
      IT=MBASIS(I)
      MBASIS(I)=MBASIS(J)
      MBASIS(J)=IT
      T=B(I)
      B(I)=B(J)
      B(J)=T
      T=CB(I)
      CB(I)=CB(J)
      CB(J)=T
      DO 10 K=1,M1
      T=B1(I,K)
      B1(I,K)=B1(J,K)
      B1(J,K)=T
   10 CONTINUE
   15 CONTINUE
      X(MBASIS(I))=B(I)
   20 CONTINUE
      RETURN
      END
```

```
   SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  SALL

VARIABLES      SN  TYPE          RELOCATION
    0  B           REAL     ARRAY     F.P.          0  B1      REAL      ARRAY   F.P.
    0  CB          REAL     ARRAY     F.P.         64  I       INTEGER
   66  IT          INTEGER                         65  J       INTEGER
   70  K           INTEGER                          0  MBASIS  INTEGER   ARRAY   F.P.
    0  MD1         INTEGER            F.P.          0  MD2     INTEGER           F.P.
   63  MN          INTEGER                          0  M1      INTEGER           F.P.
    0  N1          INTEGER            F.P.         67  T       REAL
    0  X           REAL     ARRAY     F.P.

STATEMENT LABELS
    0  5                          0  10                          52  15
    0  20
```

```
      SUBROUTINE SALL        74/835   OPT=1                                      FTN 4.8+628          85/0(

LOOPS  LABEL     INDEX      FROM-TO     LENGTH     PROPERTIES
   16  5         I             7 9          2B        OPT
   22  20        I            10 29        40B                  NOT INNER
   24  15        J            11 27        31B                  NOT INNER
   45  10        K            22 26         4B        OPT

STATISTICS
  PROGRAM LENGTH                 112B        74
          52000B CM USED
```

```
      SUBROUTINE EXPAND (B,X1,MBASIS,MBE,M1,N1,MD1,MD3)
C     PURPOSE - TO EXPAND MBASIS AND X.
C
      DIMENSION B(MD1),X1(MD3),MBASIS(MD1),MBE(MD3)
      MN=M1+N1
      DO 10 I=1,MN
      MBE(I)=0
      X1(I)=0.0
   10 CONTINUE

      DO 20 I=1,M1
      MBE(MBASIS(I))=1
      X1(MBASIS(I))=B(I)
   20 CONTINUE
      RETURN
      END
```

```
      SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  EXPAND

VARIABLES       SN  TYPE            RELOCATION
    0  B          REAL        ARRAY     F.P.         33  I          INTEGER
    0  MBASIS     INTEGER     ARRAY     F.P.          0  MBE        INTEGER     ARRAY     F.P.
    0  MD1        INTEGER               F.P.          0  MD3        INTEGER               F.P.
   32  MN         INTEGER                             0  M1         INTEGER               F.P.
    0  N1         INTEGER               F.P.          0  X1         REAL        ARRAY     F.P.

STATEMENT LABELS
    0  10                                     0  20

LOOPS  LABEL    INDEX    FROM-TO    LENGTH    PROPERTIES
   14  10       I          6  9        2B        OPT
   26  20       I         11 14        3B        OPT

STATISTICS
  PROGRAM LENGTH                  34B       28
         52000B CM USED
```

```
      SUBROUTINE FLP2 (A,B,C,C1,X1,B1,MBASIS,MBE,PL,QU,A2,B2,B3,C2,
     + M1,N1,N,M2,N2,MD0,MD1,MD2,MD3)
C     PURPOSE - TO FORM THE LINEAR PROGRAM FOR THE PRICES.
C
      DIMENSION A(MD1,MD1),B(MD1),X1(MD3),B1(MD1,MD1),C(MD2),C1(MD2)
      DIMENSION MBASIS(MD1),MBE(MD3)
      DIMENSION PL(MD0),QU(MD0)
      DIMENSION A2(MD1,MD2),B2(MD1),C2(MD2)
      DIMENSION B3(MD1)

      EPS2=.001
      DO 5 I=1,N1
      B2(I)=0.0
      B3(I)=0.0
      C2(I)=0.0
      DO 5 J=1,N1
      A2(I,J)=0.0
    5 CONTINUE

      L=0
      DO 10 I=1,N1
      IF (MBE(I).EQ.1) GO TO 10
      IC=0
      L=L+1
      DO 12 J=1,N1
      IF (MBE(J).EQ.1) GO TO 12
      IF (MBE(J).EQ.0) IC=IC+1
      IF (IC.EQ.L) A2(L,J)=1.0
   12 CONTINUE
   10 CONTINUE

      MN=M1+N1
      L=0
      DO 40 I=1,MN
      IF (MBE(I).EQ.1) GO TO 40
      L=L+1
      IF (ABS(C1(I)).GE.EPS2) B3(L)=EPS2
      DO 30 J=1,M1
      IF (MBASIS(J).GT.N1) GO TO 30
      IF (I.GT.N1) A2(L,MBASIS(J))=-B1(J,I-N1)
      IF (I.GT.N1) GO TO 30
      DO 20 K=1,M1
      A2(L,MBASIS(J))=A2(L,MBASIS(J))+B1(J,K)*A(K,I)
C
C     NOTE: -A IS SAVED
C
   20 CONTINUE
   30 CONTINUE
      TEMP=0.0
      DO 35 J1=1,N1
      TEMP=TEMP+A2(L,J1)*C(J1)
   35 CONTINUE
C     IF (TEMP.LT.0.0) PRINT *," I=",I," L=",L," TEMP=",TEMP
   40 CONTINUE
      IF (L.NE.N1) PRINT *," ERR1"," IN"," FLP2"
      IF (L.NE.N1) STOP
```

```
C       TRANSFORM COORDINATES TO Q,P

        DO 50 K=1,N1
        TEMP=0.0
        DO 52 I=1,N
        I1=7*(I-1)+1
        J1=2*(I-1)+1
C       NOTE : C(I1+3)=C(I1+7)+R(I)
C       NOTE : -C IS STORED
        B2(K)=B2(K)-A2(K,I1+2)*C(I1+2)-A2(K,I1+3)*(C(I1+3)-C(I1+7))
     + -A2(K,I1+4)*C(I1+4)
        B3(K)=B3(K)-A2(K,I1+2)*C(I1+2)-A2(K,I1+3)*(C(I1+3)-C(I1+7))
     + -A2(K,I1+4)*C(I1+4)
        A2(K,J1)=+A2(K,I1+1)+A2(K,I1+5)
        A2(K,J1+1)=-A2(K,I1+3)-A2(K,I1+7)
        TEMP=TEMP+A2(K,J1)*C(I1+1)-A2(K,J1+1)*C(I1+7)
   52   CONTINUE
C       IF (TEMP.LT.B2(K)) PRINT *," K=",K," J1=",J1," TEMP=",TEMP
   50   CONTINUE

        DO 60 I=1,N
        J1=2*(I-1)+1
        A2(N1+I,J1)=-1.0
        B2(N1+I)=-QU(I)
        B3(N1+I)=-QU(I)
        A2(N1+N+I,J1+1)=1.0
        B2(N1+N+I)=PL(I)
        B3(N1+N+I)=PL(I)
        A2(N1+2*N+I,J1)=0.9
        A2(N1+2*N+I,J1+1)=-1.0
        B2(N1+2*N+I)=0.0
        B3(N1+2*N+I)=0.0
   60   CONTINUE

        DO 70 I=1,N
        I1=7*(I-1)+1
        J1=2*(I-1)+1
        C2(J1)=-X1(I1+1)-X1(I1+5)
        C2(J1+1)=X1(I1+3)+X1(I1+7)
   70   CONTINUE
        M2=N1+3*N
        N2=2*N
        RETURN
        END
```

SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
3 FLP2

VARIABLES		SN	TYPE	RELOCATION						
0	A		REAL	ARRAY	F.P.	0	A2	REAL	ARRAY	F.P.
0	B		REAL	ARRAY	F.P.	0	B1	REAL	ARRAY	F.P.

VARIABLES SN TYPE RELOCATION

SN	NAME	TYPE		RELOCATION	SN	NAME	TYPE		RELOCATION
0	B2	REAL	ARRAY	F.P.	0	B3	REAL	ARRAY	F.P.
0	C	REAL	ARRAY	F.P.	0	C1	REAL	ARRAY	F.P.
0	C2	REAL	ARRAY	F.P.	365	EPS2	REAL		
366	I	INTEGER			371	IC	INTEGER		
376	I1	INTEGER			367	J	INTEGER		
375	J1	INTEGER			373	K	INTEGER		
370	L	INTEGER			0	MBASIS	INTEGER	ARRAY	F.P.
0	MBE	INTEGER	ARRAY	F.P.	0	MD0	INTEGER		F.P.
0	MD1	INTEGER		F.P.	0	MD2	INTEGER		F.P.
0	MD3	INTEGER		F.P.	372	MN	INTEGER		
0	M1	INTEGER		F.P.	0	M2	INTEGER		F.P.
0	N	INTEGER		F.P.	0	N1	INTEGER		F.P.
0	N2	INTEGER		F.P.	0	PL	REAL	ARRAY	F.P.
0	QU	REAL	ARRAY	F.P.	374	TEMP	REAL		
0	X1	REAL	ARRAY	F.P.					

FILE NAMES	MODE
OUTPUT	FREE

INLINE FUNCTIONS	TYPE	ARGS	
ABS	REAL	1	INTRIN

STATEMENT LABELS

0	5	55	10	53	12
0	20	130	30	0	35
146	40	0	50	0	52
0	60	0	70		

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES	
13	5	I	12 18	16B		NOT INNER
23	5	J	16 18	2B	OPT	
33	10	I	21 30	25B		NOT INNER
45	12	J	25 29	7B	OPT	
64	40	I	34 54	65B		NOT INNER
75	30	J	38 48	36B		NOT INNER
124	20	K	42 47	3B	OPT	
141	35	J1	50 52	4B	OPT	
161	50	K	60 76	67B		NOT INNER
205	52	I	62 74	37B	OPT	
273	60	I	78 90	21B	OPT	
324	70	I	92 97	10B	OPT	

STATISTICS
PROGRAM LENGTH 471B 313
52000B CM USED

```
      SUBROUTINE C1MIN (ICHW,C1,JC,MN,MD2)
C
C     PURPOSE - TO LOCATE THE SMALLEST ENTRY OF VECTOR C1.
C
      DIMENSION C1(MD2)

C     PURPOSE - TO LOCATE THE NEXT VARIABLE TO ENTER THE BASIS.
C
      EPS1=-1.0E-7
      T=C1(1)
      JC=1
      DO 10 J=1,MN
      IF (C1(J).GE.T) GO TO 10
      JC=J
      T=C1(J)
   10 CONTINUE
      IF (T.LT.EPS1) RETURN
      PRINT (ICHW,15)
   15 FORMAT ("1"/5X,"OPTIMUM SOLUTION")
      JC=10000
      RETURN
      END
```

```
      SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  C1MIN

VARIABLES      SN  TYPE           RELOCATION
    0  C1          REAL      ARRAY     F.P.          42  EPS1       REAL
    0  ICHW        INTEGER             F.P.          44  J          INTEGER
    0  JC          INTEGER             F.P.           0  MD2        INTEGER                 F.P.
    0  MN          INTEGER             F.P.          43  T          REAL

STATEMENT LABELS
   21  10                                   34  15       FMT

LOOPS  LABEL     INDEX      FROM-TO     LENGTH     PROPERTIES
   16  10        J            12 16        4B          OPT

STATISTICS
  PROGRAM LENGTH                  47B       39
          52000B CM USED
```

```
      SUBROUTINE SORT3 (ICHW,B,MBASIS,COL,IR,M1,MD1)
C
C     PURPOSE - TO SORT ACCORDING TO SIMPLEX METHOD.
C
      DIMENSION B(MD1),MBASIS(MD1),COL(MD1)

      EPS=1.0E-7
      I=1
    1 IF(COL(I).GE.EPS) GO TO 6
      I=I+1
      IF (I.GT.M1) GO TO 6
      GO TO 1
    2 T1=B(I)/COL(I)
      IR=I
    3 I=I+1
      IF (I.GT.M1) GO TO 5
      IF(COL(I).GE.EPS) GO TO 4
      GO TO 3
    4 T2=B(I)/COL(I)
      IF (T2.GE.T1) GO TO 3
      IR=I
      T1=T2
      GO TO 3
    5 RETURN
C
C     FAILURE OF THE RATIO TEST INDICATES TERMINATION
C     WITH NO SOLUTION.
C
    6 PRINT (ICHW,7)
    7 FORMAT (5X,"MODIFIED PROBLEM HAS NO SOLUTION")
      IR=10000
      RETURN
      END
```

SYMBOLIC REFERENCE MAP (R=1)

```
ENTRY POINTS
    3  SORT3

VARIABLES       SN  TYPE            RELOCATION
    0  B            REAL        ARRAY      F.P.          0  COL        REAL       ARRAY      F.P.
   61  EPS          REAL                                62  I          INTEGER
    0  ICHW         INTEGER                F.P.          0  IR         INTEGER               F.P.
    0  MBASIS       INTEGER     ARRAY      F.P.          0  MD1        INTEGER               F.P.
    0  M1           INTEGER                F.P.         63  T1         REAL
   64  T2           REAL

STATEMENT LABELS
   10  1                                     0  2           INACTIVE              24  3
   33  4                                    43  5                                 44  6
   53  7        FMT
```

```
STATISTICS
  PROGRAM LENGTH                  65B       53
          52000B CM USED
```

```
              SUBROUTINE LININ
            + (IOPT,JOPT,A,B,C,A1,B1,C1,P,Q,R,G,U,
            + KOPT,XL,XU,PL,QU,N,MR,NP2,K1,K2,
            + DT,R1,R2,S,DECI,BETA,EPS,DEL,RGAM,RMEU,
            + MD0,MD1,MD2)
      C       PURPOSE - THIS ROUTINE PREPARES DATA FOR THE LINEAR
      C                 PROGRAMMING.
      C
              DIMENSION A1(MD1,MD2),B1(MD1),C1(MD2)
              DIMENSION XL(MD0),XU(MD0)
              DIMENSION A(MD1,MD2),B(MD1),C(MD2)
              DIMENSION PL(MD0),QU(MD0)
              INTEGER KOPT(MD0)

              REAL P(MD0),Q(MD0),R(MD0),G(MD0),U(MD0)

              COMMON /ICH/ICHR,ICHW,ICH2,ICH3
      C       REWIND ICH2
              REWIND ICH3

              CALL SCHIN
            + (IOPT,A1,B1,C1,C,P,Q,R,G,U,N,M1,M2,NP,
            + DT,R1,R2,S,BETA,EPS,DEL,RGAM,RMEU,
            + MD0,MD1,MD2)
              M3=M1+M2
              READ (3,*) JOPT,DECI,N1
              IF(N1.NE.N) PRINT *," N IS NOT"," EQUAL N1"
              IF(N1.NE.N) STOP
              READ (ICH3,*) ((PL(I),QU(I)),I=1,N1)
              IF(JOPT.EQ.2) READ (ICH3,*) ((KOPT(I),XL(I),XU(I)),I=1,N1)
              IF(JOPT.EQ.1) PRINT (ICHW,5)
        5     FORMAT("1"/9X,"K",4X,"PL(K)",5X,"QU(K)")
              IF(JOPT.EQ.2) PRINT (ICHW,6)
        6     FORMAT("1"/9X,"K",4X,"PL(K)",5X,"QU(K)",
            + 6X,"KOPT",7X,"BUY",6X,"SELL")
              DO 9 I=1,N
              IF(JOPT.EQ.1) PRINT (ICHW,7)
            + I,PL(I),QU(I)
        7     FORMAT(5X,I5,1X,2(F8.4,2X))
              IF(JOPT.EQ.2) PRINT (ICHW,8)
            + I,PL(I),QU(I),KOPT(I),XL(I),XU(I)
        8     FORMAT(5X,I5,1X,2(F8.4,2X),3X,I5,2X,2(F8.2,2X))
        9     CONTINUE

              DO 10 I=1,MD1
              B(I)=0.0
              DO 10 J=1,MD2
              A(I,J)=0.0
       10     CONTINUE
              DO 12 J=1,MD2
              C(J)=0.0
       12     CONTINUE

              DO 20 I=1,M3
              DO 20 J=1,NP
              A(I,J)=-A1(I,J)
       20     CONTINUE
```

```
      DO 30 I=1,M2
      DO 30 J=1,NP
      A(M3+I,J)=A1(M1+I,J)
   30 CONTINUE

      DO 40 I=1,M3
      B(I)=-B1(I)
   40 CONTINUE
      DO 50 I=1,M2
      B(M3+I)=B1(M1+I)
   50 CONTINUE

      DO 70 I=1,NP
      C(I)=-C1(I)
   70 CONTINUE
      NP2=NP
      MR=M3+M2
      IF(JOPT.EQ.1) RETURN

      M32=M3+M2
      DO 32 I=1,N
      I1=7*(I-1)+1
      IF(KOPT(I).EQ.0) A(M32+I,I1+1)=1
      IF(KOPT(I).EQ.0) A(M32+I,I1+5)=1
      IF(KOPT(I).EQ.0) B(M32+I)=0.
      IF(KOPT(I).EQ.0) A(M32+N+I,I1+3)=1
      IF(KOPT(I).EQ.0) A(M32+N+I,I1+7)=1
      IF(KOPT(I).EQ.0) B(M32+N+I)=0.

      IF(KOPT(I).EQ.0) A(M32+I,I1+1)=-1
      IF(KOPT(I).EQ.0) A(M32+I,I1+5)=-1
      IF(KOPT(I).EQ.0) B(M32+I)=-XL(I)
      IF(KOPT(I).EQ.0) A(M32+N+I,I1+3)=-1
      IF(KOPT(I).EQ.0) A(M32+N+I,I1+7)=-1
      IF(KOPT(I).EQ.0) B(M32+N+I)=-XU(I)

      IF((KOPT(I).EQ.1).OR.(KOPT(I).EQ.2)) A(M32+I,I1+1)=1
      IF((KOPT(I).EQ.1).OR.(KOPT(I).EQ.2)) A(M32+I,I1+5)=1
      IF((KOPT(I).EQ.1).OR.(KOPT(I).EQ.2)) B(M32+I)=XL(I)
      IF((KOPT(I).EQ.3).OR.(KOPT(I).EQ.4)) A(M32+I,I1+1)=-1
      IF((KOPT(I).EQ.3).OR.(KOPT(I).EQ.4)) A(M32+I,I1+5)=-1
      IF((KOPT(I).EQ.3).OR.(KOPT(I).EQ.4)) B(M32+I)=-XL(I)
      IF((KOPT(I).EQ.1).OR.(KOPT(I).EQ.3)) A(M32+N+I,I1+3)=1
      IF((KOPT(I).EQ.1).OR.(KOPT(I).EQ.3)) A(M32+N+I,I1+7)=1
      IF((KOPT(I).EQ.1).OR.(KOPT(I).EQ.3)) B(M32+N+I)=XU(I)
      IF((KOPT(I).EQ.2).OR.(KOPT(I).EQ.4)) A(M32+N+I,I1+3)=-1
      IF((KOPT(I).EQ.2).OR.(KOPT(I).EQ.4)) A(M32+N+I,I1+7)=-1
      IF((KOPT(I).EQ.2).OR.(KOPT(I).EQ.4)) B(M32+N+I)=-XU(I)

      IF((KOPT(I).EQ.1).OR.(KOPT(I).EQ.2)) A(M32+2*N+I,I1+1)=-1
      IF((KOPT(I).EQ.1).OR.(KOPT(I).EQ.2)) A(M32+2*N+I,I1+5)=-1
      IF((KOPT(I).EQ.1).OR.(KOPT(I).EQ.2)) B(M32+2*N+I)=-XL(I)
      IF((KOPT(I).EQ.3).OR.(KOPT(I).EQ.4)) A(M32+2*N+I,I1+1)=1
      IF((KOPT(I).EQ.3).OR.(KOPT(I).EQ.4)) A(M32+2*N+I,I1+5)=1
      IF((KOPT(I).EQ.3).OR.(KOPT(I).EQ.4)) B(M32+2*N+I)=XL(I)
      IF((KOPT(I).EQ.1).OR.(KOPT(I).EQ.3)) A(M32+3*N+I,I1+3)=-1
      IF((KOPT(I).EQ.1).OR.(KOPT(I).EQ.3)) A(M32+3*N+I,I1+7)=-1
```

```
          IF((KOPT(I).EQ.1).OR.(KOPT(I).EQ.3)) B(M32+3*N+I)=-XU(I)
          IF((KOPT(I).EQ.2).OR.(KOPT(I).EQ.4)) A(M32+3*N+I,I1+3)=1
          IF((KOPT(I).EQ.2).OR.(KOPT(I).EQ.4)) A(M32+3*N+I,I1+7)=1
          IF((KOPT(I).EQ.2).OR.(KOPT(I).EQ.4)) B(M32+3*N+I)=XU(I)
   32     CONTINUE
          K1=M32+1
          K2=M32+4*N

          NP2=NP
          MR=M3+M2+4*N
          RETURN
          END
```

```
      SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  LININ

VARIABLES     SN  TYPE            RELOCATION
    0  A          REAL      ARRAY     F.P.            0  A1        REAL      ARRAY     F.P.
    0  B          REAL      ARRAY     F.P.            0  BETA      REAL                F.P.
    0  B1         REAL      ARRAY     F.P.            0  C         REAL      ARRAY     F.P.
    0  C1         REAL      ARRAY     F.P.            0  DECI      REAL                F.P.
    0  DEL        REAL                F.P.            0  DT        REAL                F.P.
    0  EPS        REAL                F.P.            0  G         REAL      ARRAY     F.P.
 1100  I          INTEGER                             0  ICHR      INTEGER             ICH
    1  ICHW       INTEGER             ICH             2  ICH2      INTEGER             ICH
    3  ICH3       INTEGER             ICH             0  IOPT      INTEGER             F.P.
 1103  I1         INTEGER                          1101  J         INTEGER
    0  JOPT       INTEGER             F.P.            0  KOPT      INTEGER   ARRAY     F.P.
    0  K1         INTEGER             F.P.            0  K2        INTEGER             F.P.
    0  MD0        INTEGER             F.P.            0  MD1       INTEGER             F.P.
    0  MD2        INTEGER             F.P.            0  MR        INTEGER             F.P.
 1073  M1         INTEGER                          1074  M2        INTEGER
 1076  M3         INTEGER                          1102  M32       INTEGER
    0  N          INTEGER             F.P.         1075  NP        INTEGER
    0  NP2        INTEGER             F.P.         1077  N1        INTEGER
    0  P          REAL      ARRAY     F.P.            0  PL        REAL      ARRAY     F.P.
    0  Q          REAL      ARRAY     F.P.            0  QU        REAL      ARRAY     F.P.
    0  R          REAL      ARRAY     F.P.            0  RGAM      REAL                F.P.
    0  RMEU       REAL                F.P.            0  R1        REAL                F.P.
    0  R2         REAL                F.P.            0  S         REAL                F.P.
    0  U          REAL      ARRAY     F.P.            0  XL        REAL      ARRAY     F.P.
    0  XU         REAL      ARRAY     F.P.

FILE NAMES      MODE
       OUTPUT   FREE            TAPE3     FREE

EXTERNALS          TYPE    ARGS
       SCHIN                26
```

STATEMENT LABELS

1023	5	FMT	1033	6	FMT	1051	7	
1065	8	FMT	0	9		0	10	
0	12		0	20		0	30	
0	32		0	40		0	50	
0	70							

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES	
73		I	29 29	10B		EXT REFS
111		I	30 30	12B		EXT REFS
135	9	I	36 43	27B		EXT REFS
165	10	I	45 49	15B		NOT INNER
174	10	J	47 49	2B	OPT	
206	12	J	50 52	2B	OPT	
212	20	I	54 57	15B		NOT INNER
221	20	J	55 57	2B	OPT	
230	30	I	58 61	17B		NOT INNER
241	30	J	59 61	2B	OPT	
254	40	I	63 65	2B	OPT	
267	50	I	66 68	2B	OPT	
276	70	I	70 72	2B	OPT	
332	32	I	78 119	357B	OPT	

COMMON BLOCKS	LENGTH
ICH	4

STATISTICS

PROGRAM LENGTH	1267B	695
CM LABELED COMMON LENGTH	4B	4

76700B CM USED

```
            SUBROUTINE SCHIN
          + (IOPT,A,B,C,C1,P,Q,R,G,U,N,M1,M2,NP,
          + DT,R1,R2,S,BETA,EPS,DEL,RGAM,RMEU,
          + MD1,MD2,MD3)

            REAL A(MD2,MD3),B(MD2),C(MD3),C1(MD3)
            REAL P(MD1),Q(MD1),R(MD1),G(MD1),U(MD1)

            COMMON /ICH/ICHR,ICHW,ICH2,ICH3

      C
      C    THIS ROUTINE FORMULATES THE OPERATIONS OF
      C    LOCAL SMALL POWER PRODUCER.
      C
      C     PROGRAMMER : HASSAN GHOUDJEHBAKLOU
      C     DATE       : 10/20/84
      C
      C     OPTIONS : IOPT=
      C                           PRODUCER   UTILITY
      C                           ------------------
      C     FIXED                 !   1    !    2  !
      C                           ------------------
      C     SHIFTABLE             !   3    !    4  !
      C                           ------------------
            PRINT (ICHW,2)
        2   FORMAT("1")
            READ (ICHR,5) IC
        5   FORMAT(A1)
            READ (ICHR,*) IOPT,DT,N
            PRINT (ICHW,6) IOPT,DT,N
        6   FORMAT(5X,"IOPT=",I2,5X,"DT=",F8.2,2X,"N=",I5/)

            IF ((IOPT.EQ.1).OR.(IOPT.EQ.2)) CALL IN1
          + (ICHR,ICHW,R1,R2,S,EPS,DEL,RGAM,RMEU,N,P,Q,R,G,U,MD1)
            IF((IOPT.EQ.3).OR.(IOPT.EQ.4)) CALL IN2
          + (ICHR,ICHW,R1,R2,S,EPS,DEL,RGAM,RMEU,N,P,Q,R,G,UT,UL,UH,MD1)
            IF((IOPT.EQ.5).OR.(IOPT.EQ.6)) CALL IN3
          + (ICHR,ICHW,R1,R2,S,BETA,EPS,DEL,RGAM,RMEU,N,P,Q,R,G,UT,UL,UH,MD1)

            IF((IOPT.EQ.1).OR.(IOPT.EQ.2)) CALL FRMLP1
          + (R1,R2,S,EPS,DEL,RGAM,RMEU,DT,N,P,Q,R,G,U,MD1,
          + A,B,C,C1,M1,M2,NP,MD2,MD3)
            IF((IOPT.EQ.3).OR.(IOPT.EQ.4)) CALL FRMLP2
          + (R1,R2,S,EPS,DEL,RGAM,RMEU,DT,N,P,Q,R,G,UT,UL,UH,MD1,
          + A,B,C,C1,M1,M2,NP,MD2,MD3)
            IF((IOPT.EQ.5).OR.(IOPT.EQ.6)) CALL FRMLP3
          + (R1,R2,S,BETA,EPS,DEL,RGAM,RMEU,DT,N,P,Q,R,G,UT,UL,UH,MD1,
          + A,B,C,C1,M1,M2,NP,MD2,MD3)

            RETURN
            END
```

```
     SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  SCHIN

VARIABLES      SN  TYPE           RELOCATION
    0  A           REAL       ARRAY      F.P.          0  B        REAL       ARRAY    F.P.
    0  BETA        REAL                  F.P.          0  C        REAL       ARRAY    F.P.
    0  C1          REAL       ARRAY      F.P.          0  DEL      REAL                F.P.
    0  DT          REAL                  F.P.          0  EPS      REAL                F.P.
    0  G           REAL       ARRAY      F.P.        573  IC       INTEGER
    0  ICHR        INTEGER             ICH             1  ICHW     INTEGER             ICH
    2  ICH2        INTEGER             ICH             3  ICH3     INTEGER             ICH
    0  IOPT        INTEGER               F.P.          0  MD1      INTEGER             F.P.
    0  MD2         INTEGER               F.P.          0  MD3      INTEGER             F.P.
    0  M1          INTEGER               F.P.          0  M2       INTEGER             F.P.
    0  N           INTEGER               F.P.          0  NP       INTEGER             F.P.
    0  P           REAL       ARRAY      F.P.          0  Q        REAL       ARRAY    F.P.
    0  R           REAL       ARRAY      F.P.          0  RGAM     REAL                F.P.
    0  RMEU        REAL                  F.P.          0  R1       REAL                F.P.
    0  R2          REAL                  F.P.          0  S        REAL                F.P.
    0  U           REAL       ARRAY      F.P.        576  UH       REAL
  575  UL          REAL                              574  UT       REAL

EXTERNALS          TYPE    ARGS
       FRMLP1               24                          FRMLP2               26
       FRMLP3               27                          IN1                  16
       IN2                  18                          IN3                  19

STATEMENT LABELS
  540  2        FMT                       547  5       FMT                     565  6

COMMON BLOCKS   LENGTH
       ICH           4

STATISTICS
  PROGRAM LENGTH                577B     383
  CM LABELED COMMON LENGTH        4B       4
          52000B CM USED
```

```
                  SUBROUTINE IN1
     + (ICHR,ICHW,R1,R2,S,EPS,DEL,RGAM,RMEU,N,P,Q,R,G,U,MD1)

      COMMON /BLK1/ PS(24),QS(24),RS(24),GS(24),US(24)
      REAL P(MD1),Q(MD1),R(MD1),G(MD1),U(MD1)

C
C     THIS ROUTINE READS THE INPUT FILE AND PRINTS OUT A COPY OF THEM.
C

      READ (ICHR,5) IC
    5 FORMAT(A1)
      READ (ICHR,*) R1,R2,S,EPS,DEL
      PRINT (ICHW,7) R1,R2,S,EPS,DEL
    7 FORMAT(5X,"R1=",F8.2,2X,"R2=",F8.2,2X,"S=",F8.2,2X,
     + "EPS=",F5.3,5X,"DEL=",F5.3,5X)
      READ (ICHR,5) IC
      READ (ICHR,*) RGAM,RMEU
      PRINT (ICHW,8) RGAM,RMEU
    8 FORMAT(5X,"GAMMA=",F5.3,5X,"MEU=",F5.3/)
      READ (ICHR,5) IC
      PRINT (ICHW,9)
    9 FORMAT(9X,"K",4X,"P(K)",6X,"Q(K)",6X,"R(K)",8X,"G(K)",6X,"U(K)")
      IFLAG=0
      IF(IFLAG.EQ.1) GO TO 22
      DO 20 I=1,N
      READ (ICHR,*) K,P(K),Q(K),R(K),G(K),U(K)
      PRINT (ICHW,15) K,P(K),Q(K),R(K),G(K),U(K)
   20 CONTINUE
      READ (ICHR,5) IC
      RETURN
   22 DO 11 I=1,MD1
      READ (ICHR,*) K,PS(K),QS(K),RS(K),GS(K),US(K)
   11 CONTINUE
      IDT=MD1/N
      DO 10 K=1,N
      P(K)=0.
      Q(K)=0.
      R(K)=0.
      G(K)=0.
      U(K)=0.
      I1=IDT*(K-1)
      DO 12 J=1,IDT
      P(K)=P(K)+PS(I1+J)
      Q(K)=Q(K)+QS(I1+J)
      R(K)=R(K)+RS(I1+J)
      G(K)=G(K)+GS(I1+J)
      U(K)=U(K)+US(I1+J)
   12 CONTINUE
      P(K)=P(K)/IDT
      Q(K)=Q(K)/IDT
      R(K)=R(K)/IDT
      PRINT (ICHW,15) K,P(K),Q(K),R(K),G(K),U(K)
   15 FORMAT(5X,I5,3(F8.4,2X),2(F10.2))
   10 CONTINUE
      READ (ICHR,5) IC
      RETURN
```

```
                    END




      SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3   IN1

VARIABLES      SN  TYPE            RELOCATION
    0  DEL        REAL                  F.P.             0  EPS        REAL                 F.P.
    0  G          REAL       ARRAY      F.P.           110  GS         REAL       ARRAY     BLK1
  354  I          INTEGER                              352  IC         INTEGER
    0  ICHR       INTEGER               F.P.             0  ICHW       INTEGER              F.P.
  356  IDT        INTEGER                              353  IFLAG      INTEGER
  357  I1         INTEGER                              360  J          INTEGER
  355  K          INTEGER                                0  MD1        INTEGER              F.P.
    0  N          INTEGER               F.P.             0  P          REAL       ARRAY     F.P.
    0  PS         REAL       ARRAY    BLK1               0  Q          REAL       ARRAY     F.P.
   30  QS         REAL       ARRAY    BLK1               0  R          REAL       ARRAY     F.P.
    0  RGAM       REAL                  F.P.             0  RMEU       REAL                 F.P.
   60  RS         REAL       ARRAY    BLK1               0  R1         REAL                 F.P.
    0  R2         REAL                  F.P.             0  S          REAL                 F.P.
    0  U          REAL       ARRAY      F.P.           140  US         REAL       ARRAY     BLK1

STATEMENT LABELS
  170  5        FMT                         212  7       FMT                       242  8
  257  9        FMT                           0  10                                  0  11
    0  12                                   341  15      FMT                         0  20
   64  22

LOOPS  LABEL     INDEX      FROM-TO     LENGTH     PROPERTIES
   31  20        I           26  29      30B                 EXT REFS
   65  11        I           32  34      16B                 EXT REFS
  110  10        K           36  55      50B                 EXT REFS  NOT INNER
  123  12        J           43  49      13B          OPT

COMMON BLOCKS   LENGTH
       BLK1        120

STATISTICS
  PROGRAM LENGTH                 421B        273
  CM LABELED COMMON LENGTH       170B        120
          52000B CM USED
```

```
      SUBROUTINE IN2
     + (ICHR,ICHW,R1,R2,S,EPS,DEL,RGAM,RMEU,N,P,Q,R,G,UT,UL,UH,MD1)

      COMMON /BLK1/ PS(24),QS(24),RS(24),GS(24),US(24)
      REAL P(MD1),Q(MD1),R(MD1),G(MD1)

C
C     THIS ROUTINE READS THE INPUT FILE AND PRINTS OUT A COPY OF THEM.
C

      READ (ICHR,5) IC
    5 FORMAT(A1)
      READ (ICHR,*) R1,R2,S,EPS,DEL
      PRINT (ICHW,7) R1,R2,S,EPS,DEL
    7 FORMAT(5X,"R1=",F8.2,2X,"R2=",F8.2,2X,"S=",F8.2,2X.
     + "EPS=",F5.3,5X,"DEL=",F5.3,5X)
      READ (ICHR,5) IC
      READ (ICHR,*) RGAM,RMEU
      PRINT (ICHW,6) RGAM,RMEU
    6 FORMAT(5X,"GAMMA=",F5.3,5X,"MEU=",F5.3/)
      READ (ICHR,5) IC
      READ (ICHR,*) UT,UL,UH
      PRINT (ICHW,8) UT,UL,UH
    8 FORMAT(5X,"UT=",F8.2,2X,"UL=",F8.2,2X,"UH=",F8.2//)
      READ (ICHR,5) IC
      PRINT (ICHW,9)
    9 FORMAT(9X,"K",4X,"P(K)",6X,"Q(K)",6X,"R(K)",8X,"G(K)")
      IFLAG=0
      IF(IFLAG.EQ.1) GO TO 22
      DO 20 I=1,N
      READ (ICHR,*) K,P(K),Q(K),R(K),G(K)
      PRINT (ICHW,15) K,P(K),Q(K),R(K),G(K)
   20 CONTINUE
      READ (ICHR,5) IC
      RETURN
   22 DO 11 I=1,MD1
      READ (ICHR,*) K,PS(K),QS(K),RS(K),GS(K),US(K)
   11 CONTINUE
      IDT=MD1/N
      DO 10 K=1,N
      P(K)=0.
      Q(K)=0.
      R(K)=0.
      G(K)=0.
      I1=IDT*(K-1)
      DO 12 J=1,IDT
      P(K)=P(K)+PS(I1+J)
      Q(K)=Q(K)+QS(I1+J)
      R(K)=R(K)+RS(I1+J)
      G(K)=G(K)+GS(I1+J)
   12 CONTINUE
      P(K)=P(K)/IDT
      Q(K)=Q(K)/IDT
      R(K)=R(K)/IDT
      PRINT (ICHW,15) K,P(K),Q(K),R(K),G(K)
   15 FORMAT(5X,I5,3(F8.4,2X),F10.2)
   10 CONTINUE
```

```
                        READ (ICHR,5) IC
                        RETURN
 60                     END
```

```
     SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  IN2

VARIABLES      SN  TYPE            RELOCATION
     0  DEL          REAL                  F.P.          0  EPS      REAL                   F.P.
     0  G            REAL      ARRAY       F.P.        110  GS       REAL        ARRAY      BLK1
   400  I            INTEGER                           376  IC       INTEGER
     0  ICHR         INTEGER               F.P.          0  ICHW     INTEGER                F.P.
   402  IDT          INTEGER                           377  IFLAG    INTEGER
   403  I1           INTEGER                           404  J        INTEGER
   401  K            INTEGER                             0  MD1      INTEGER                F.P.
     0  N            INTEGER               F.P.          0  P        REAL        ARRAY      F.P.
     0  PS           REAL      ARRAY      BLK1           0  Q        REAL        ARRAY      F.P.
    30  QS           REAL      ARRAY      BLK1           0  R        REAL        ARRAY      F.P.
     0  RGAM         REAL                  F.P.          0  RMEU     REAL                   F.P.
    60  RS           REAL      ARRAY      BLK1           0  R1       REAL                   F.P.
     0  R2           REAL                  F.P.          0  S        REAL                   F.P.
     0  UH           REAL                  F.P.          0  UL       REAL                   F.P.
   140  US           REAL      ARRAY      BLK1           0  UT       REAL                   F.P.

STATEMENT LABELS
   171  5        FMT                    243  6       FMT                    213  7
   271  8        FMT                    307  9       FMT                      0  10
     0  11                                0  12                             365  15
     0  20                               70  22

LOOPS  LABEL    INDEX     FROM-TO    LENGTH     PROPERTIES
   37  20       I          30 33      26B                 EXT REFS
   71  11       I          36 38      16B                 EXT REFS
  114  10       K          40 57      45B                 EXT REFS  NOT INNER
  131  12       J          46 51      10B           OPT

COMMON BLOCKS    LENGTH
       BLK1          120

STATISTICS
  PROGRAM LENGTH                   441B      289
  CM LABELED COMMON LENGTH         170B      120
        52000B CM USED
```

```
      SUBROUTINE IN3
     + (ICHR,ICHW,R1,R2,S,BETA,EPS,DEL,RGAM,RMEU,N,P,Q,R,G,UT,UL,UH,MD1)

      COMMON /BLK1/ PS(24),QS(24),RS(24),GS(24),US(24)
      REAL P(MD1),Q(MD1),R(MD1),G(MD1)

C
C     THIS ROUTINE READS THE INPUT FILE AND PRINTS OUT A COPY OF THEM.
C

      READ (ICHR,5) IC
    5 FORMAT(A1)
      READ (ICHR,*) R1,R2,S,EPS,DEL
      PRINT (ICHW,7) R1,R2,S,EPS,DEL
    7 FORMAT(5X,"R1=",F8.2,2X,"R2=",F8.2,2X,"S=",F8.2,2X,
     + "EPS=",F5.3,5X,"DEL=",F5.3)
      READ (ICHR,5) IC
      READ (ICHR,*) BETA,RGAM,RMEU
      PRINT (ICHW,6) BETA,RGAM,RMEU
    6 FORMAT(5X,"BETA=",F5.3,5X,"GAMMA=",F5.3,5X,"MEU=",F5.3/)
      READ (ICHR,5) IC
      READ (ICHR,*) UT,UL,UH
      PRINT (ICHW,8) UT,UL,UH
    8 FORMAT(5X,"UT=",F8.2,2X,"UL=",F8.2,2X,"UH=",F8.2//)
      READ (ICHR,5) IC
      PRINT (ICHW,9)
    9 FORMAT(9X,"K",4X,"P(K)",6X,"Q(K)",6X,"R(K)",8X,"G(K)")
      IFLAG=0
      IF(IFLAG.EQ.1) GO TO 22
      DO 20 I=1,N
      READ (ICHR,*) K,P(K),Q(K),R(K),G(K)
      PRINT (ICHW,15) K,P(K),Q(K),R(K),G(K)
   20 CONTINUE
      READ (ICHR,5) IC
      RETURN
   22 DO 11 I=1,MD1
      READ (ICHR,*) K,PS(K),QS(K),RS(K),GS(K),US(K)
   11 CONTINUE
      IDT=MD1/N
      DO 10 K=1,N
      P(K)=0.
      Q(K)=0.
      R(K)=0.
      G(K)=0.
      I1=IDT*(K-1)
      DO 12 J=1,IDT
      P(K)=P(K)+PS(I1+J)
      Q(K)=Q(K)+QS(I1+J)
      R(K)=R(K)+RS(I1+J)
      G(K)=G(K)+GS(I1+J)
   12 CONTINUE
      P(K)=P(K)/IDT
      Q(K)=Q(K)/IDT
      R(K)=R(K)/IDT
      PRINT (ICHW,15) K,P(K),Q(K),R(K),G(K)
   15 FORMAT(5X,I5,3(F8.4,2X),F10.2)
   10 CONTINUE
```

```
                    READ (ICHR,5) IC
                    RETURN
 60                 END
```

```
      SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  IN3

VARIABLES       SN  TYPE           RELOCATION
    0  BETA         REAL                 F.P.          0  DEL        REAL                F.P.
    0  EPS          REAL                 F.P.          0  G          REAL       ARRAY    F.P.
  110  GS           REAL       ARRAY    BLK1         403  I          INTEGER
  401  IC           INTEGER                            0  ICHR       INTEGER             F.P.
    0  ICHW         INTEGER              F.P.        405  IDT        INTEGER
  402  IFLAG        INTEGER                          406  I1         INTEGER
  407  J            INTEGER                          404  K          INTEGER
    0  MD1          INTEGER              F.P.          0  N          INTEGER             F.P.
    0  P            REAL       ARRAY     F.P.          0  PS         REAL       ARRAY    BLK1
    0  Q            REAL       ARRAY     F.P.         30  QS         REAL       ARRAY    BLK1
    0  R            REAL       ARRAY     F.P.          0  RGAM       REAL                F.P.
    0  RMEU         REAL                 F.P.         60  RS         REAL       ARRAY    BLK1
    0  R1           REAL                 F.P.          0  R2         REAL                F.P.
    0  S            REAL                 F.P.          0  UH         REAL                F.P.
    0  UL           REAL                 F.P.        140  US         REAL       ARRAY    BLK1
    0  UT           REAL                 F.P.

STATEMENT LABELS
  171  5        FMT                       245  6       FMT                     213  7
  274  8        FMT                       312  9       FMT                       0  10
    0  11                                   0  12                              370  15
    0  20                                  70  22

LOOPS  LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
   37  20       I          30 33       26B               EXT REFS
   71  11       I          36 38       16B               EXT REFS
  114  10       K          40 57       45B               EXT REFS  NOT INNER
  131  12       J          46 51       10B          OPT

COMMON BLOCKS   LENGTH
       BLK1        120

STATISTICS
  PROGRAM LENGTH                  444B      292
  CM LABELED COMMON LENGTH        170B      120
          52000B CM USED
```

```
      SUBROUTINE FRMLP1(R1,R2,S,EPS,DEL,RGAM,RMEU,DT,N,P,Q,R,G,U,MD1,
     + A,B,C,C1,M1,M2,NP,MD2,MD3)

      REAL P(MD1),Q(MD1),R(MD1),G(MD1),U(MD1)
      REAL A(MD2,MD3),B(MD2),C(MD3),C1(MD3)

C
C     THIS ROUTINE FORMS THE OPERATING MATRICES FOR THE LINEAR
C     PROGRAMMING EXECUTION.
C

      M1=5*N-1
      M2=N+1
      NP=7*N+1

C     CLEAR A,B,C
      M3=M1+M2+2
      DO 2 I=1,M3
      B(I)=0
      DO 2 J=1,NP
      A(I,J)=0
    2 CONTINUE
      DO 3 J=1,NP
      C(J)=0
      C1(J)=0
    3 CONTINUE

C     M1 INEQUALITY CONSTRAINTS
      A(1,1)=1
      B(1)=S
      DO 30 K=1,N
      I1=3*(K-1)+1
      I2=7*(K-1)+1
      A(I1+1,I2+1)=EPS
      A(I1+1,I2+2)=EPS
      B(I1+1)=R1*DT

      A(I1+2,I2+2)=1
      A(I1+2,I2+3)=1.0/RGAM
      A(I1+2,I2+4)=1
      B(I1+2)=G(K)

      A(I1+3,I2+6)=1.0/DEL
      A(I1+3,I2+7)=1.0/DEL
      B(I1+3)=R2*DT
   30 CONTINUE

      TMEU1=1.0/RMEU
      N1=N-1
      DO 40 J=1,N1
      TMEU2=1.0/RMEU
      TMEU1=TMEU1*RMEU
      J1=2*(J-1)
      A(I1+J1+4,1)=TMEU1
      A(I1+J1+5,1)=-TMEU1
      B(I1+J1+4)=S
      B(I1+J1+5)=0
```

```
          DO 50 K1=1,J
          TMEU2=TMEU2*RMEU
          K=J-K1+1
          K2=7*(K-1)+1
          A(I1+J1+4,K2+1)=EPS*TMEU2
          IF (K.NE.J) A(I1+J1+5,K2+1)=-EPS*TMEU2
          A(I1+J1+4,K2+2)=EPS*TMEU2
          IF (K.NE.J) A(I1+J1+5,K2+2)=-EPS*TMEU2
          A(I1+J1+4,K2+6)=-TMEU2/DEL
          A(I1+J1+5,K2+6)=TMEU2/DEL
          A(I1+J1+4,K2+7)=-TMEU2/DEL
          A(I1+J1+5,K2+7)=TMEU2/DEL
   50     CONTINUE
   40     CONTINUE

C         M2 EQUALITY CONSTRAINTS

          DO 60 K=1,N
          I2=7*(K-1)+1
          A(M1+K,I2+4)=1
          A(M1+K,I2+5)=RGAM
          A(M1+K,I2+6)=1
          B(M1+K)=U(K)
   60     CONTINUE

          A(M1+N+1,1)=TMEU2*RMEU-1.0
          C(1)=-1.0E-8
          TMEU1=1.0/RMEU
          DO 70 K1=1,N
          TMEU1=TMEU1*RMEU
          K=N-K1+1
          I2=7*(K-1)+1
          A(M1+N+1,I2+1)=EPS*TMEU1
          A(M1+N+1,I2+2)=EPS*TMEU1
          A(M1+N+1,I2+6)=-TMEU1/DEL
          A(M1+N+1,I2+7)=-TMEU1/DEL
          C(I2+1)=-Q(K)
          C(I2+2)=-R(K)
          C(I2+3)=P(K)-R(K)/RGAM
          C(I2+4)=-R(K)
          C(I2+5)=-Q(K)
          C(I2+7)=P(K)

          C1(I2+1)=Q(K)
          C1(I2+3)=-P(K)
          C1(I2+5)=Q(K)
          C1(I2+7)=-P(K)

   70     CONTINUE
          B(M1+N+1)=0
          RETURN
          END
```

SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
3 FRMLP1

VARIABLES SN TYPE RELOCATION

SN	NAME	TYPE		RELOCATION	SN	NAME	TYPE		RELOCATION
0	A	REAL	ARRAY	F.P.	0	B	REAL	ARRAY	F.P.
0	C	REAL	ARRAY	F.P.	0	C1	REAL	ARRAY	F.P.
0	DEL	REAL		F.P.	0	DT	REAL		F.P.
0	EPS	REAL		F.P.	0	G	REAL	ARRAY	F.P.
352	I	INTEGER			355	I1	INTEGER		
356	I2	INTEGER			353	J	INTEGER		
362	J1	INTEGER			354	K	INTEGER		
363	K1	INTEGER			364	K2	INTEGER		
0	MD1	INTEGER		F.P.	0	MD2	INTEGER		F.P.
0	MD3	INTEGER		F.P.	0	M1	INTEGER		F.P.
0	M2	INTEGER		F.P.	351	M3	INTEGER		
0	N	INTEGER		F.P.	0	NP	INTEGER		F.P.
360	N1	INTEGER			0	P	REAL	ARRAY	F.P.
0	Q	REAL	ARRAY	F.P.	0	R	REAL	ARRAY	F.P.
0	RGAM	REAL		F.P.	0	RMEU	REAL		F.P.
0	R1	REAL		F.P.	0	R2	REAL		F.P.
0	S	REAL		F.P.	357	TMEU1	REAL		
361	TMEU2	REAL			0	U	REAL	ARRAY	F.P.

STATEMENT LABELS

0	2	0	3	0	30
0	40	0	50	0	60
0	70				

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES	
21	2	I	18 22	15B		NOT INNER
30	2	J	20 22	2B	OPT	
43	3	J	23 26	2B	OPT	
107	30	K	31 46	22B	OPT	
137	40	J	50 71	61B		NOT INNER
164	50	K1	58 70	30B	OPT	
241	60	K	75 81	7B	OPT	
300	70	K1	86 106	26B	OPT	

STATISTICS
PROGRAM LENGTH 427B 279
52000B CM USED

```
      SUBROUTINE FRMLP2
     + (R1,R2,S,EPS,DEL,RGAM,RMEU,DT,N,P,Q,R,G,UT,UL,UH,MD1,
     + A,B,C,C1,M1,M2,NP,MD2,MD3)

      REAL P(MD1),Q(MD1),R(MD1),G(MD1)
      REAL A(MD2,MD3),B(MD2),C(MD3),C1(MD3)

C
C     THIS ROUTINE FORMS THE OPERATING MATRICES FOR THE LINEAR
C     PROGRAMMING EXECUTION.
C

      M1=7*N-1
      M2=N+2
      NP=8*N+1

C     CLEAR A,B,C
      M3=M1+M2+2
      DO 2 I=1,M3
      B(I)=0
      DO 2 J=1,NP
      A(I,J)=0
    2 CONTINUE
      DO 3 J=1,NP
      C(J)=0
      C1(J)=0
    3 CONTINUE

C     M1 INEQUALITY CONSTRAINTS
      A(1,1)=1
      B(1)=S
      DO 30 K=1,N
      I1=5*(K-1)+1
      I2=8*(K-1)+1
      A(I1+1,I2+1)=EPS
      A(I1+1,I2+2)=EPS
      B(I1+1)=R1*DT

      A(I1+2,I2+2)=1
      A(I1+2,I2+3)=1.0/RGAM
      A(I1+2,I2+4)=1
      B(I1+2)=G(K)

      A(I1+3,I2+6)=1.0/DEL
      A(I1+3,I2+7)=1.0/DEL
      B(I1+3)=R2*DT

      A(I1+4,I2+8)=1
      B(I1+4)=UH

      A(I1+5,I2+8)=-1
      B(I1+5)=-UL
   30 CONTINUE
      M4=5*N+1

      TMEU1=1.0/RMEU
      N1=N-1
```

```
      DO 40 J=1,N1
      TMEU2=1.0/RMEU
      TMEU1=TMEU1*RMEU
      J1=2*(J-1)
      A(M4+J1+1,1)=TMEU1
      A(M4+J1+2,1)=-TMEU1
      B(M4+J1+1)=S
      B(M4+J1+2)=0
      DO 50 K1=1,J
      TMEU2=TMEU2*RMEU
      K=J-K1+1
      K2=8*(K-1)+1
      A(M4+J1+1,K2+1)=EPS*TMEU2
      IF(K.NE.J) A(M4+J1+2,K2+1)=-EPS*TMEU2
      A(M4+J1+1,K2+2)=EPS*TMEU2
      IF(K.NE.J) A(M4+J1+2,K2+2)=-EPS*TMEU2
      A(M4+J1+1,K2+6)=-TMEU2/DEL
      A(M4+J1+2,K2+6)=TMEU2/DEL
      A(M4+J1+1,K2+7)=-TMEU2/DEL
      A(M4+J1+2,K2+7)=TMEU2/DEL
   50 CONTINUE
   40 CONTINUE

C     M2 EQUALITY CONSTRAINTS

      DO 60 K=1,N
      I2=8*(K-1)+1
      A(M1+K,I2+4)=1
      A(M1+K,I2+5)=RGAM
      A(M1+K,I2+6)=1
      A(M1+K,I2+8)=-1
   60 CONTINUE

      A(M1+N+1,1)=TMEU2*RMEU-1.0
      C(1)=-1.0E-8
      TMEU1=1.0/RMEU
      DO 70 K1=1,N
      TMEU1=TMEU1*RMEU
      K=N-K1+1
      I2=8*(K-1)+1
      A(M1+N+1,I2+1)=EPS*TMEU1
      A(M1+N+1,I2+2)=EPS*TMEU1
      A(M1+N+1,I2+6)=-TMEU1/DEL
      A(M1+N+1,I2+7)=-TMEU1/DEL
      A(M1+N+2,I2+8)=1

      C(I2+1)=-Q(K)
      C(I2+2)=-R(K)
      C(I2+3)=P(K)-R(K)/RGAM
      C(I2+4)=-R(K)
      C(I2+5)=-Q(K)
      C(I2+7)=P(K)

      C1(I2+1)=Q(K)
      C1(I2+3)=-P(K)
      C1(I2+5)=Q(K)
      C1(I2+7)=-P(K)
```

```
      70    CONTINUE
            B(M1+N+1)=0
            B(M1+N+2)=UT
            RETURN
            END
```

```
     SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    5  FRMLP2

VARIABLES     SN  TYPE           RELOCATION
    0  A          REAL      ARRAY     F.P.            0  B        REAL      ARRAY     F.P.
    0  C          REAL      ARRAY     F.P.            0  C1       REAL      ARRAY     F.P.
    0  DEL        REAL                F.P.            0  DT       REAL                F.P.
    0  EPS        REAL                F.P.            0  G        REAL      ARRAY     F.P.
  400  I          INTEGER                           403  I1       INTEGER
  404  I2         INTEGER                           401  J        INTEGER
  411  J1         INTEGER                           402  K        INTEGER
  412  K1         INTEGER                           413  K2       INTEGER
    0  MD1        INTEGER             F.P.            0  MD2      INTEGER             F.P.
    0  MD3        INTEGER             F.P.            0  M1       INTEGER             F.P.
    0  M2         INTEGER             F.P.          377  M3       INTEGER
  405  M4         INTEGER                             0  N        INTEGER             F.P.
    0  NP         INTEGER             F.P.          407  N1       INTEGER
    0  P          REAL      ARRAY     F.P.            0  Q        REAL      ARRAY     F.P.
    0  R          REAL      ARRAY     F.P.            0  RGAM     REAL                F.P.
    0  RMEU       REAL                F.P.            0  R1       REAL                F.P.
    0  R2         REAL                F.P.            0  S        REAL                F.P.
  406  TMEU1      REAL                              410  TMEU2    REAL
    0  UH         REAL                F.P.            0  UL       REAL                F.P.
    0  UT         REAL                F.P.

STATEMENT LABELS
    0  2                                   0  3                                  0  30
    0  40                                  0  50                                 0  60
    0  70

LOOPS  LABEL    INDEX      FROM-TO     LENGTH    PROPERTIES
   20  2        I           19  23       15B                 NOT INNER
   27  2        J           21  23        2B          OPT
   42  3        J           24  27        2B          OPT
  113  30       K           32  53       27B          OPT
  151  40       J           58  79       61B                 NOT INNER
  176  50       K1          66  78       30B          OPT
  255  60       K           83  89        7B          OPT
  320  70       K1          94 116       30B          OPT

STATISTICS
  PROGRAM LENGTH                 457B     303
        52000B CM USED
```

```
      SUBROUTINE FRMLP3
     + (R1,R2,S,BETA,EPS,DEL,RGAM,RMEU,DT,N,P,Q,R,G,UT,UL,UH,MD1,
     + A,B,C,C1,M1,M2,NP,MD2,MD3)

      REAL P(MD1),Q(MD1),R(MD1),G(MD1)
      REAL A(MD2,MD3),B(MD2),C(MD3),C1(MD3)

C
C     THIS ROUTINE FORMS THE OPERATING MATRICES FOR THE LINEAR
C     PROGRAMMING EXECUTION.
C

      M1=7*N-1
      M2=2*N+2
      NP=10*N+1

C     CLEAR A,B,C
      M3=M1+M2+2
      DO 2 I=1,M3
      B(I)=0
      DO 2 J=1,NP
      A(I,J)=0
 2    CONTINUE
      DO 3 J=1,NP
      C(J)=0
      C1(J)=0
 3    CONTINUE

C     M1 INEQUALITY CONSTRAINTS
      A(1,1)=1
      B(1)=S
      DO 30 K=1,N
      I1=5*(K-1)+1
      I2=10*(K-1)+1
      A(I1+1,I2+1)=EPS
      A(I1+1,I2+2)=EPS
      A(I1+1,I2+9)=EPS
      B(I1+1)=R1*DT

      A(I1+2,I2+2)=1
      A(I1+2,I2+3)=1.0/RGAM
      A(I1+2,I2+4)=1
      B(I1+2)=G(K)

      A(I1+3,I2+6)=1.0/DEL
      A(I1+3,I2+7)=1.0/DEL
      B(I1+3)=R2*DT

      A(I1+4,I2+8)=1
      B(I1+4)=UH

      A(I1+5,I2+8)=-1
      B(I1+5)=-UL
 30   CONTINUE
      M4=5*N+1

      TMEU1=1.0/RMEU
```

```
      N1=N-1
      DO 40 J=1,N1
      TMEU2=1.0/RMEU
      TMEU1=TMEU1*RMEU
      J1=2*(J-1)
      A(M4+J1+1,1)=TMEU1
      A(M4+J1+2,1)=-TMEU1
      B(M4+J1+1)=S
      B(M4+J1+2)=0
      DO 50 K1=1,J
      TMEU2=TMEU2*RMEU
      K=J-K1+1
      K2=10*(K-1)+1
      A(M4+J1+1,K2+1)=EPS*TMEU2
      IF(K.NE.J)  A(M4+J1+2,K2+1)=-EPS*TMEU2
      A(M4+J1+1,K2+2)=EPS*TMEU2
      IF(K.NE.J)  A(M4+J1+2,K2+2)=-EPS*TMEU2
      A(M4+J1+1,K2+9)=EPS*TMEU2
      IF(K.NE.J)  A(M4+J1+2,K2+9)=-EPS*TMEU2
      A(M4+J1+1,K2+6)=-TMEU2/DEL
      A(M4+J1+2,K2+6)=TMEU2/DEL
      A(M4+J1+1,K2+7)=-TMEU2/DEL
      A(M4+J1+2,K2+7)=TMEU2/DEL
   50 CONTINUE
   40 CONTINUE

C     M2 EQUALITY CONSTRAINTS

      DO 60 K=1,N
      I2=10*(K-1)+1
      A(M1+K,I2+4)=1
      A(M1+K,I2+5)=RGAM
      A(M1+K,I2+6)=1
      A(M1+K,I2+8)=-1
      A(M1+N+K,I2+9)=1
      A(M1+N+K,I2+10)=1.0/RGAM
      A(M1+N+K,I2+8)=-BETA
   60 CONTINUE

      A(M1+2*N+1,1)=TMEU2*RMEU-1.0
      C(1)=-1.0E-8
      TMEU1=1.0/RMEU
      DO 70 K1=1,N
      TMEU1=TMEU1*RMEU
      K=N-K1+1
      I2=10*(K-1)+1
      A(M1+2*N+1,I2+1)=EPS*TMEU1
      A(M1+2*N+1,I2+2)=EPS*TMEU1
      A(M1+2*N+1,I2+9)=EPS*TMEU1
      A(M1+2*N+1,I2+6)=-TMEU1/DEL
      A(M1+2*N+1,I2+7)=-TMEU1/DEL
      A(M1+2*N+2,I2+8)=1

      C(I2+1)=-Q(K)
      C(I2+2)=-R(K)
      C(I2+3)=P(K)-R(K)/RGAM
      C(I2+4)=-R(K)
```

```
                  C(I2+5)=-Q(K)
                  C(I2+7)=P(K)
                  C(I2+10)=P(K)

                  C1(I2+1)=Q(K)
                  C1(I2+3)=-P(K)
                  C1(I2+5)=Q(K)
                  C1(I2+7)=-P(K)
                  C1(I2+10)=-P(K)

           70     CONTINUE
                  B(M1+2*N+2)=UT
                  RETURN
                  END
```

```
   SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  FRMLP3

VARIABLES      SN  TYPE         RELOCATION
    0  A           REAL       ARRAY     F.P.            0  B       REAL       ARRAY     F.P.
    0  BETA        REAL                 F.P.            0  C       REAL       ARRAY     F.P.
    0  C1          REAL       ARRAY     F.P.            0  DEL     REAL                 F.P.
    0  DT          REAL                 F.P.            0  EPS     REAL                 F.P.
    0  G           REAL       ARRAY     F.P.          464  I       INTEGER
  467  I1          INTEGER                            470  I2      INTEGER
  465  J           INTEGER                            475  J1      INTEGER
  466  K           INTEGER                            476  K1      INTEGER
  477  K2          INTEGER                              0  MD1     INTEGER              F.P.
    0  MD2         INTEGER              F.P.            0  MD3     INTEGER              F.P.
    0  M1          INTEGER              F.P.            0  M2      INTEGER              F.P.
  463  M3          INTEGER                            471  M4      INTEGER
    0  N           INTEGER              F.P.            0  NP      INTEGER              F.P.
  473  N1          INTEGER                              0  P       REAL       ARRAY     F.P.
    0  Q           REAL       ARRAY     F.P.            0  R       REAL       ARRAY     F.P.
    0  RGAM        REAL                 F.P.            0  RMEU    REAL                 F.P.
    0  R1          REAL                 F.P.            0  R2      REAL                 F.P.
    0  S           REAL                 F.P.          472  TMEU1   REAL
  474  TMEU2       REAL                                 0  UH      REAL                 F.P.
    0  UL          REAL                 F.P.            0  UT      REAL                 F.P.

STATEMENT LABELS
    0  2                          0  3                          0  30
    0  40                         0  50                         0  60
    0  70

LOOPS  LABEL    INDEX   FROM-TO   LENGTH   PROPERTIES
  21   2        I        19 23     15B             NOT INNER
  30   2        J        21 23      2B        OPT
  43   3        J        24 27      2B        OPT
 116   30       K        32 54     32B        OPT
 157   40       J        59 82     73B             NOT INNER
```

```
LOOPS  LABEL    INDEX    FROM-TO     LENGTH    PROPERTIES
  206  50 .     K1         67 81        40B        OPT
  320  60       K          86 95        16B        OPT
  377  70       K1        100 125       33B        OPT

STATISTICS
  PROGRAM LENGTH                  552B      362
          52000B CM USED
```

```
                 SUBROUTINE OUT(ICHW,IOPT,PSOL,N,SMAX,IER,MD3)

                 REAL PSOL(MD3)

           C
           C     THIS ROUTINE OUTPUTS THE RESULTS OF THE OPTIMUM SPOT PRICING
           C     PROCEDURE.
           C

                 IF((IOPT.EQ.1).OR.(IOPT.EQ.2)) ISOE=7
                 IF((IOPT.EQ.3).OR.(IOPT.EQ.4)) ISOE=8
                 IF((IOPT.EQ.5).OR.(IOPT.EQ.6)) ISOE=10
                 PRINT (ICHW,5)
             5   FORMAT("1")
                 PRINT (ICHW,7) PSOL(1),SMAX,IER
             7   FORMAT(10X,"X0=",F8.2,8X,"REVENUE=",F10.2,8X,"ERROR=",I5/)
                 PRINT (ICHW,12) (I,I=1,ISOE)
            12   FORMAT(8X,"    K     ",10(I5,5X))
                 PRINT (ICHW,14)
            14   FORMAT(4X,"PERIOD")
                 DO 10 K=1,N
                 I2=ISOE*(K-1)+1
                 PRINT (ICHW,15) K,(PSOL(I2+I),I=1,ISOE)
            15   FORMAT(7X,I3,5X,10(F8.2,2X))
            10   CONTINUE
                 RETURN
                 END
```

```
    SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  OUT

VARIABLES      SN  TYPE           RELOCATION
  147  I          INTEGER                            0  ICHW      INTEGER                F.P.
    0  IER        INTEGER             F.P.           0  IOPT      INTEGER                F.P.
  146  ISOE       INTEGER                          151  I2        INTEGER
  150  K          INTEGER                            0  MD3       INTEGER                F.P.
    0  N          INTEGER             F.P.           0  PSOL      REAL        ARRAY      F.P.
    0  SMAX       REAL                F.P.

STATEMENT LABELS
   75  5       FMT                   105  7       FMT                          0  10
  122  12      FMT                   131  14      FMT                        143  15

LOOPS  LABEL     INDEX     FROM-TO     LENGTH    PROPERTIES
   37             I         17 17        4B            EXT REFS
   47  10         K         21 25       22B            EXT REFS  NOT INNER
   55             I         23 23       10B            EXT REFS

STATISTICS
  PROGRAM LENGTH                155B      109
        52000B CM USED
```

```
      SUBROUTINE PRSCH
     +(ICHW,IOPT,P,Q,R,U,PSOL,SCH,N,SMAX,BETA,EPS,DEL,RGAM,RMEU,MD1,MD3)

      REAL P(MD1),Q(MD1),R(MD1),U(MD1),PSOL(MD3)
      REAL SCH(MD1)

C
C     THIS ROUTINE PRINTS OUT THE OPTIMAL OPERATING SCHEDULE
C

      PRINT (ICHW,5)
    5 FORMAT("1")
      IF((IOPT.EQ.1).OR.(IOPT.EQ.3).OR.(IOPT.EQ.5)) PRINT (ICHW,10)
      IF((IOPT.EQ.2).OR.(IOPT.EQ.4).OR.(IOPT.EQ.6)) PRINT (ICHW,11)
   10 FORMAT(5X,"** OPTIMAL SCHEDULE FOR THE PRODUCER **"/)
   11 FORMAT(5X,"** OPTIMAL SCHEDULE FOR THE UTILITY **"/)
      PRINT (ICHW,12) PSOL(1)
   12 FORMAT(5X,"INITIAL STORAGE ENERGY LEVEL=",F8.2//)
      PRINT (ICHW,15)
   15 FORMAT
     + (7X,"PRODUCE",5X,"COGEN",6X,"USE",7X,"SELL",6X," BUY",5X,"STORE"
     + ,6X,"LEVEL",5X,"LOSS",4X,"PROFIT")
      PRINT (ICHW,17)
   17 FORMAT(2X,"PERIOD")

      IF((IOPT.EQ.1).OR.(IOPT.EQ.2)) ISOE=7
      IF((IOPT.EQ.3).OR.(IOPT.EQ.4)) ISOE=8
      IF((IOPT.EQ.5).OR.(IOPT.EQ.6)) ISOE=10
      IF((ISOE.EQ.7).OR.(ISOE.EQ.8)) BETA=0.

      STORED=PSOL(1)
      DO 20 K=1,N
      I2=ISOE*(K-1)+1
      PRODUCE=PSOL(I2+2)+PSOL(I2+3)/RGAM+PSOL(I2+4)
      USE=PSOL(I2+4)+RGAM*PSOL(I2+5)+PSOL(I2+6)
      COGEN=BETA*USE
      IF((IOPT.EQ.3).OR.(IOPT.EQ.4)) U(K)=USE
      IF((IOPT.EQ.5).OR.(IOPT.EQ.6)) U(K)=USE
      STR=0
      DSC=0
      IF((IOPT.EQ.5).OR.(IOPT.EQ.6)) STR=PSOL(I2+9)
      IF((IOPT.EQ.5).OR.(IOPT.EQ.6)) DSC=PSOL(I2+10)
      SELL=PSOL(I2+3)+PSOL(I2+7)+DSC
      BUY=PSOL(I2+1)+PSOL(I2+5)
      SCH(K)=SELL-BUY
      STORE=
     +EPS*(PSOL(I2+1)+PSOL(I2+2)+STR)-(PSOL(I2+6)+PSOL(I2+7))/DEL
      STORED=STORED*RMEU+STORE
      RLOSS=(1-EPS)*(PSOL(I2+1)+PSOL(I2+2)+STR)
     + +(1-DEL)*(PSOL(I2+6)+PSOL(I2+7))/DEL
     + +(1-RGAM)*(PSOL(I2+3)/RGAM+PSOL(I2+5))
      PROFIT=SELL*P(K)-BUY*Q(K)-PRODUCE*R(K)
      PRINT (ICHW,25)
     + K,PRODUCE,COGEN,USE,SELL,BUY,STORE,STORED,RLOSS,PROFIT
   25 FORMAT(2X,I2,2X,9(F8.2,2X))
   20 CONTINUE
      PRINT (ICHW,30) SMAX
```

```
              30     FORMAT(5X,"TOTAL REVENUE=",F10.2)
                     RETURN
    60               END


       SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  PRSCH

VARIABLES      SN  TYPE           RELOCATION
    0  BETA        REAL                F.P.        333  BUY         REAL
  327  COGEN       REAL                              0  DEL         REAL                 F.P.
  331  DSC         REAL                              0  EPS         REAL                 F.P.
    0  ICHW        INTEGER             F.P.          0  IOPT        INTEGER              F.P.
  321  ISOE        INTEGER                         324  I2          INTEGER
  323  K           INTEGER                           0  MD1         INTEGER              F.P.
    0  MD3         INTEGER             F.P.          0  N           INTEGER              F.P.
    0  P           REAL       ARRAY    F.P.        325  PRODUCE     REAL
  336  PROFIT      REAL                              0  PSOL        REAL       ARRAY     F.P.
    0  Q           REAL       ARRAY    F.P.          0  R           REAL       ARRAY     F.P.
    0  RGAM        REAL                F.P.        335  RLOSS       REAL
    0  RMEU        REAL                F.P.          0  SCH         REAL       ARRAY     F.P.
  332  SELL        REAL                              0  SMAX        REAL                 F.P.
  334  STORE       REAL                            322  STORED      REAL
  330  STR         REAL                              0  U           REAL       ARRAY     F.P.
  326  USE         REAL

STATEMENT LABELS
  206  5      FMT                      216  10     FMT                         224  11
  236  12     FMT                      247  15     FMT                         265  17
    0  20                              305  25     FMT                         314  30

LOOPS  LABEL    INDEX    FROM-TO    LENGTH    PROPERTIES
   70  20       K         32 56      107B               EXT REFS

STATISTICS
  PROGRAM LENGTH              365B      245
        52000B CM USED
```

```
      SUBROUTINE IN11
     + (ICHW,ICH4,IOPT,DT,R1,R2,S,EPS,DEL,RGAM,RMEU,N,P,Q,R,G,U,MD1)

      REAL P(MD1),Q(MD1),R(MD1),G(MD1),U(MD1)

C
C     THIS ROUTINE OUTPUTS THE FINAL PRICES AND OTHER INFORMATION.
C

      PRINT (ICHW,2)
    2 FORMAT ("1")
      IC="C"
      PRINT (ICH4,5) IC
    5 FORMAT(A1)
      PRINT (ICH4,*) IOPT,DT,N
      PRINT (ICHW,6) IOPT,DT,N
    6 FORMAT(5X,"IOPT=",I2,5X,"DT=",F8.2,2X,"N=",I5/)
      PRINT (ICH4,5) IC
      PRINT (ICH4,*) R1,R2,S,EPS,DEL
      PRINT (ICHW,7) R1,R2,S,EPS,DEL
    7 FORMAT(5X,"R1=",F8.2,2X,"R2=",F8.2,2X,"S=",F8.2,2X,
     +"EPS=",F5.3,5X,"DEL=",F5.3,5X)
      PRINT (ICH4,5) IC
      PRINT (ICH4,*) RGAM,RMEU
      PRINT (ICHW,8) RGAM,RMEU
    8 FORMAT(5X,"GAMMA=",F5.3,5X,"MEU=",F5.3/)
      PRINT (ICH4,5) IC
      PRINT (ICHW,9)
    9 FORMAT(9X,"K",4X,"P(K)",6X,"Q(K)",6X,"R(K)",8X,"G(K)",6X,"U(K)")
      DO 10 K=1,N
      PRINT (ICH4,*) K,P(K),Q(K),R(K),G(K),U(K)
      PRINT (ICHW,15) K,P(K),Q(K),R(K),G(K),U(K)
   15 FORMAT(5X,I5,3(F8.4,2X),2(F10.2))
   10 CONTINUE
      PRINT (ICH4,5) IC
      RETURN
      END
```

SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
3 IN11

VARIABLES SN	TYPE		RELOCATION					
0	DEL	REAL		F.P.	0	DT	REAL		F.P.
0	EPS	REAL		F.P.	0	G	REAL	ARRAY	F.P.
254	IC	INTEGER			0	ICHW	INTEGER		F.P.
0	ICH4	INTEGER		F.P.	0	IOPT	INTEGER		F.P.
255	K	INTEGER			0	MD1	INTEGER		F.P.
0	N	INTEGER		F.P.	0	P	REAL	ARRAY	F.P.
0	Q	REAL	ARRAY	F.P.	0	R	REAL	ARRAY	F.P.
0	RGAM	REAL		F.P.	0	RMEU	REAL		F.P.
0	R1	REAL		F.P.	0	R2	REAL		F.P.

```
VARIABLES      SN  TYPE            RELOCATION
    0  S          REAL                  F.P.            0  U          REAL         ARRAY      F.P.

STATEMENT LABELS
   75  2        FMT                         103  5       FMT                            120  6
  151  7        FMT                         177  8       FMT                            213  9
    0  10                                   243  15      FMT

LOOPS  LABEL     INDEX      FROM-TO     LENGTH     PROPERTIES
   40  10        K            30 34       27B                 EXT REFS

STATISTICS
  PROGRAM LENGTH                272B     186
          52000B CM USED
```

APPENDIX 8

PROGRAM TSCH

LISTING

```
      PROGRAM TSCH
     + (INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,
     + SPEC1,DTVA1,TAPE1=SPEC1,TAPE2=DTVA1,TAPE7,TAPE9)

      COMMON /BLK1/ PS(24),QS(24),RS(24),GS(24),US(24)
      REAL A(195,193),B(195),C(193),C1(193)
      REAL PSOL(193),DSOL(195),RW(38522),IW(497)
      REAL P(24),Q(24),R(24),G(24),U(24)
      REAL IBUF(512),SCH(24),SCHT(24),SCHL(24),SCHW(24),NAME(3)

C
C     THIS PROGRAM CONMPUTES AN OPTIMAL SCHEDULE FOR OPERATION OF
C     LOCAL SMALL POWER PRODUCER.
C
C     PROGRAMMER : HASSAN GHOUDJEHBAKLOU
C     DATE       : 3/1/84
C
C     OPTIONS : IOPT=
C                                  PRODUCER   UTILITY
C                                  ------------------
C     FIXED                        !   1    !    2   !
C                                  ------------------
C     SHIFTABLE                    !   3    !    4   !
C                                  ------------------
C     COGENERATION                 !   5    !    6   !
C                                  ------------------
C
C
C
C
C     M1 = NUMBER OF INEQUALITIES
C     M2 = NUMBER OF EQUALITIES
C     24=N
C
C
C     M1=7*N-1
C     M2=N+2
C     M1+
C     195
C     193
C     385
C     496
C
C       D
C       M
C       M
C       M
C       2
C       2
C       4
C       6
C

      ICI
      ICI
      ICI
      ICI
      IC
```

```
         MD1=24
         MD2=195
         MD3=193

         CALL PLOTS(IBUF,512,9,00)
         PRINT (ICHT,2)
    2    FORMAT("1")
    5    FORMAT(A1)
         SPPFC=0
         SPPFR=0
         FAC=1.
         READ (ICH1,5) IC
         READ (ICH1,*) MK1,SRATE
         PRINT(ICHW,*)"  ","RATE FOR"," NON-SPPF"," =",SRATE," ($/MWH)"
         IF (MK1.EQ.1) MK="MWH"
         IF (MK1.EQ.2) MK="KWH"
         READ (ICH1,*) (SCHL(I),I=1,MD1)
         READ (ICH1,5) IC
         COST=0.
         DO 1 I=1,MD1
         COST=COST+SRATE*SCHL(I)
C        SPPFR=SPPFR+(SRATE-GRATE)*SCHL(I)
    1    CONTINUE
         SPPFR=COST
         READ (ICH1,*) DT,N
         IDT=MD1/N
         DO 15 K=1,N
         TEMP=0
         I1=IDT*(K-1)
         DO 16 J=1,IDT
         TEMP=TEMP+SCHL(I1+J)
   16    CONTINUE
         SCHT(K)=0.
         SCHL(K)=TEMP
   15    CONTINUE
         NAME(1)="NON-SPPF"
         NAME(2)="          "
         NAME(3)="          "
         PRINT (ICHW,19)(NAME(I),I=1,3),DT,MK
   19    FORMAT(//3X,"NAME = ",3A10,2X,"DT = ",F8.2,5X,"UNIT = ",A3/)
         PRINT (ICHW,21)(I,I=1,10)
         PRINT (ICHW,22)(SCHL(I),I=1,N)
         PRINT (ICHW,3) COST
C3       FORMAT(/5X,"COST FOR NON-SPPF =",F15.2/
C      + 5X,"REVENUE FROM NON-SPPF =",F15.2)
    3    FORMAT(/5X,"REVENUE FROM NON-SPPF =",F15.2)
         CALL QUAL(ICHW,SCHL,QF1,QF2,N,MD1)
         CALL TRANS(SCHL,SCHW,DT,N,MD1)
         CALL PLTSQ(0.,0.,7.,7.,FAC,-SPPFR,DT,NAME(1),NAME(2),NAME(3))
         IF(MK1.EQ.1) CALL PLT1
       + (SCHW,.5,.5,DT,N,FAC,"TIME","SCHEDULE MW",4,11,MD1)
         IF(MK1.EQ.2) CALL PLT1
       + (SCHW,.5,.5,DT,N,FAC,"TIME","SCHEDULE KW",4,11,MD1)
         CALL PLOT(8.,0.,-3)
         READ (ICH1,5) IC
         READ (ICH2,5) IC
```

```
      READ (ICH2,*) NSPPF
      DO 50 ICT=1,NSPPF
      READ (ICH2,*) NO,MWORKW
      IF(MWORKW.EQ.1) MK="MWH"
      IF(MWORKW.EQ.2) MK="KWH"
      READ (ICH2,7) (NAME(I),I=1,3)
      READ (ICH1,*) IOPT
      IF (IOPT.EQ.0) GO TO 8
      PRINT (ICHT,6) IOPT,DT,N,(NAME(I),I=1,3)
    6 FORMAT("1",5X,"IOPT=",I2,5X,"DT=",F8.2,2X,"N=",I5,2X,"NAME =",
     + 3A10)

      IF ((IOPT.EQ.1).OR.(IOPT.EQ.2)) CALL IN1
     + (ICH1,ICHT,R1,R2,S,EPS,DEL,RGAM,RMEU,N,MD1)
C     IF ((IOPT.EQ.1).OR.(IOPT.EQ.2)) CALL IN11
C    + (ICHT,IOPT,DT,R1,R2,S,EPS,DEL,RGAM,RMEU,N,MD1)
      IF((IOPT.EQ.3).OR.(IOPT.EQ.4)) CALL IN2
     + (ICH1,ICHT,DT,R1,R2,S,EPS,DEL,RGAM,RMEU,N,UT,UL,UH,MD1)
      IF((IOPT.EQ.5).OR.(IOPT.EQ.6)) CALL IN3
     + (ICH1,ICHT,
     + DT,R1,R2,S,BETA,EPS,DEL,RGAM,RMEU,N,P,Q,R,G,UT,UL,UH,MD1)

    8 CONTINUE
      PRINT (ICHW,13) (NAME(I),I=1,3),DT,NO,MK
   13 FORMAT (//3X,"NAME = ",3A10,2X,"DT = ",F8.2,5X,"ID NO =",I3
     + ,5X,"UNIT = ",A3/)
    7 FORMAT (3A10)
      PRINT (ICHT,9)
    9 FORMAT(9X,"K",4X,"P(K)",6X,"Q(K)",6X,"R(K)",8X,"G(K)",6X,"U(K)")
      DO 11 I=1,MD1
      READ (ICH2,*) K,PS(K),QS(K),RS(K),GS(K),US(K)
   11 CONTINUE
      IDT=MD1/N
      DO 10 K=1,N
      P(K)=0.
      Q(K)=0.
      R(K)=0.
      G(K)=0.
      U(K)=0.
      I1=IDT*(K-1)
      DO 12 J=1,IDT
      P(K)=P(K)+PS(I1+J)
      Q(K)=Q(K)+QS(I1+J)
      R(K)=R(K)+RS(I1+J)
      G(K)=G(K)+GS(I1+J)
      U(K)=U(K)+US(I1+J)
   12 CONTINUE
      P(K)=P(K)/IDT
      Q(K)=Q(K)/IDT
      R(K)=R(K)/IDT
      PRINT (ICHT,17) K,P(K),Q(K),R(K),G(K),U(K)
   17 FORMAT(5X,I5,3(F8.4,2X),2(F10.2))
   10 CONTINUE
      READ (ICH2,5) IC
      IF (IOPT.EQ.0) GO TO 50

      IF((IOPT.EQ.1).OR.(IOPT.EQ.2)) CALL FRMLP1
```

```
     + (R1,R2,S,EPS,DEL,RGAM,RMEU,DT,N,P,Q,R,G,U,MD1,
     + A,B,C,C1,M1,M2,NP,MD2,MD3)
       IF((IOPT.EQ.3).OR.(IOPT.EQ.4)) CALL FRMLP2
     + (R1,R2,S,EPS,DEL,RGAM,RMEU,DT,N,P,Q,R,G,UT,UL,UH,MD1,
     + A,B,C,C1,M1,M2,NP,MD2,MD3)
       IF((IOPT.EQ.5).OR.(IOPT.EQ.6)) CALL FRMLP3
     + (R1,R2,S,BETA,EPS,DEL,RGAM,RMEU,DT,N,P,Q,R,G,UT,UL,UH,MD1,
     + A,B,C,C1,M1,M2,NP,MD2,MD3)

       IF((IOPT.EQ.1).OR.(IOPT.EQ.3).OR.(IOPT.EQ.5)) CALL ZX3LP
     + (A,MD2,B,C,NP,M1,M2,SMAX,PSOL,DSOL,RW,IW,IER)
       IF((IOPT.EQ.2).OR.(IOPT.EQ.4).OR.(IOPT.EQ.6)) CALL ZX3LP
     + (A,MD2,B,C1,NP,M1,M2,SMAX,PSOL,DSOL,RW,IW,IER)

       CALL OUT(ICHT,IOPT,PSOL,N,SMAX,IER,MD3)

       CALL PRSCH
     + (ICHT,IOPT
     + ,P,Q,R,U,PSOL,SCH,N,SMAX,COST,BETA,EPS,DEL,RGAM,RMEU,MD1,MD3)

       PRINT (ICHW,21) (I,I=1,10)
  21   FORMAT (5X,"K",I4,9I10/)
       PRINT (ICHW,22) (SCH(I),I=1,N)
  22   FORMAT (5X,10(F8.2,2X)/5X,10(F8.2,2X))
       DO 30 I=1,N
C      SCHT(I)=SCHT(I)-SCH(I)
       IF(MWORKW.EQ.1) SCHT(I)=SCHT(I)+SCH(I)
       IF(MWORKW.EQ.2) SCHT(I)=SCHT(I)+.001*SCH(I)
  30   CONTINUE
C      PRINT (ICHW,23) SMAX,COST
C23    FORMAT(/5X,"NET REVENUE FOR SPPF = ",F10.2
C    + /5X,"COST TO UTILITY = ",F10.2)
       IF (SMAX.GE.0.) PRINT (ICHW,41) SMAX
       IF (SMAX.LE.0.) PRINT (ICHW,42) -SMAX
       IF (COST.GE.0.) PRINT (ICHW,43) COST
       IF (COST.LE.0.) PRINT (ICHW,44) -COST
  41   FORMAT(/5X,"NET REVENUE FOR SPPF =",F15.2)
  42   FORMAT(/5X,"NET COST FOR SPPF =",F15.2)
  43   FORMAT(5X,"NET COST FOR UTILITY =",F15.2)
  44   FORMAT(5X,"NET REVENUE FOR UTILITY =",F15.2)
       SPPFC=SPPFC+COST
       SPPFR=SPPFR-COST
       CALL TRANS(SCH,SCHW,DT,N,MD1)
       CALL PLTSQ(0.,0.,7.,7.,FAC,COST,DT,NAME(1),NAME(2),NAME(3))
       IF(MWORKW.EQ.1) CALL PLT1
     + (SCHW,.5,.5,DT,N,FAC,"TIME","SCHEDULE MW",4,11,MD1)
       IF(MWORKW.EQ.2) CALL PLT1
     + (SCHW,.5,.5,DT,N,FAC,"TIME","SCHEDULE KW",4,11,MD1)
       CALL PLOT(8.,0.,-3)
  50   CONTINUE
       PRINT (ICHW,35)
  35   FORMAT(//"** TOTAL LOADS OF SPPFS **"/)
       PRINT (ICHW,21)(I,I=1,10)
       PRINT (ICHW,22)(SCHT(I),I=1,N)
C      PRINT (ICHW,34) SPPFR
C34    FORMAT(/5X,"TOTAL REVENUE OF SPPFS = ",F15.2)
       IF(SPPFC.LE.0.) PRINT(ICHW,46) -SPPFC
```

```
                  IF(SPPFC.GE.0.) PRINT(ICHW,47) SPPFC
         46       FORMAT(/5X,"TOTAL REVENUE FROM SPPFS =",F15.2)
         47       FORMAT(/5X,"TOTAL COSTS FROM SPPFS =",F15.2)
                  NAME(1)="TOTAL LOAD"
                  NAME(2)=" OF SPPFS "
                  NAME(3)="          "
                  COST=SPPFC
                  CALL TRANS(SCHT,SCHW,DT,N,MD1)
                  CALL PLTSQ(0.,0.,7.,7.,FAC,COST,DT,NAME(1),NAME(2),NAME(3))
                  CALL PLT1(SCHW,.5,.5,DT,N,FAC,"TIME","SCHEDULE MW",4,11,MD1)
                  CALL PLOT(8.,0.,-3)
                  PRINT (ICHW,25)
         25       FORMAT(//,5X,"** TOTAL LOAD SEEN BY UTILITY **"/)
                  DO 26 I=1,N
        C         SCHT(I)=SCHT(I)+SCHL(I)
                  IF(MK1.EQ.1) SCHT(I)=SCHT(I)+SCHL(I)
                  IF(MK1.EQ.2) SCHT(I)=SCHT(I)+.001*SCHL(I)
         26       CONTINUE
                  PRINT (ICHW,21) (I,I=1,10)
                  PRINT (ICHW,22) (SCHT(I),I=1,N)
        C         PRINT (ICHW,24) SPPFC
        C24       FORMAT (/5X,"SPPF COSTS TO UTILITY = ",F15.2)
                  IF(SPPFR.LE.0.) PRINT(ICHW,48) -SPPFR
                  IF(SPPFR.GE.0.) PRINT(ICHW,49) SPPFR
         48       FORMAT(/5X,"TOTAL COSTS FOR UTILITY =",F15.2)
         49       FORMAT(/5X,"TOTAL REVENUE FOR UTILITY =",F15.2)
                  NAME(1)="TOTAL LOAD"
                  NAME(2)=" FOR UTILI"
                  NAME(3)="TY        "
                  CALL QUAL(ICHW,SCHT,QF1,QF2,N,MD1)
                  CALL TRANS(SCHT,SCHW,DT,N,MD1)
                  CALL PLTSQ(0.,0.,7.,7.,FAC,-SPPFR,DT,NAME(1),NAME(2),NAME(3))
                  CALL PLT1(SCHW,.5,.5,DT,N,FAC,"TIME","SCHEDULE MW",4,11,MD1)
                  CALL PLOT(0.,0.,999)

        C         READ (ICHR,10) ICOMM1,ICOMM2,ICOMM3
        C10       FORMAT(8A10)
        C         CALL PLOTS(IBUF,512,9,00)
        C         CALL PLTSQ(15.,15.,.5,SMAX,ICOMM1,ICOMM2,ICOMM3)
        C         CALL PLT1(P,1.,7.,DT,N,.5,"TIME","SELL $/KWH",4,10,MD1)
        C         CALL PLT1(Q,7.,0.,DT,N,.5,"TIME","BUY $/KWH",4,9,MD1)
        C         CALL PLT1(U,-7.,-6.,DT,N,.5,"TIME","USE $/KWH",4,9,MD1)
        C         CALL PLT1(SCH,7.,0.,DT,N,.5,"TIME","SCHEDULE KWH",4,12,MD1)
        C         CALL PLOT(0.,0.,999)
                  STOP
                  END
```

SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
14430 TSCH1

```
 VARIABLES      SN  TYPE          RELOCATION
  16531  A         REAL      ARRAY                    130134  B          REAL       ARRAY
  16523  BETA      REAL                               130437  C          REAL       ARRAY
  16472  COST      REAL                               130740  C1         REAL       ARRAY
  16515  DEL       REAL                               131542  DSOL       REAL       ARRAY
  16473  DT        REAL                                16514  EPS        REAL
  16464  FAC       REAL                               246330  G          REAL       ARRAY
    110  GS        REAL      ARRAY    BLK1             16471  I          INTEGER
 246410  IBUF      REAL      ARRAY                     16465  IC         INTEGER
  16454  ICHR      INTEGER                             16456  ICHT       INTEGER
  16455  ICHW      INTEGER                             16452  ICH1       INTEGER
  16453  ICH2      INTEGER                             16505  ICT        INTEGER
  16475  IDT       INTEGER                             16530  IER        INTEGER
  16510  IOPT      INTEGER                            245237  IW         REAL       ARRAY
  16500  I1        INTEGER                             16501  J          INTEGER
  16476  K         INTEGER                             16457  MD1        INTEGER
  16460  MD2       INTEGER                             16461  MD3        INTEGER
  16470  MK        INTEGER                             16466  MK1        INTEGER
  16507  MWORKW    INTEGER                             16524  M1         INTEGER
  16525  M2        INTEGER                             16474  N          INTEGER
 247550  NAME      REAL      ARRAY                     16506  NO         INTEGER
  16526  NP        INTEGER                             16504  NSPPF      INTEGER
 246220  P         REAL      ARRAY                         0  PS         REAL       ARRAY    BLK1
 131241  PSOL      REAL      ARRAY                    246250  Q          REAL       ARRAY
  16502  QF1       REAL                                16503  QF2        REAL
     30  QS        REAL      ARRAY    BLK1            246300  R          REAL       ARRAY
  16516  RGAM      REAL                                16517  RMEU       REAL
     60  RS        REAL      ARRAY    BLK1            132045  RW         REAL       ARRAY
  16511  R1        REAL                                16512  R2         REAL
  16513  S         REAL                               247410  SCH        REAL       ARRAY
 247470  SCHL      REAL      ARRAY                    247440  SCHT       REAL       ARRAY
 247520  SCHW      REAL      ARRAY                     16527  SMAX       REAL
  16462  SPPFC     REAL                                16463  SPPFR      REAL
  16467  SRATE     REAL                                16477  TEMP       REAL
 246360  U         REAL      ARRAY                     16522  UH         REAL
  16521  UL        REAL                                  140  US         REAL       ARRAY    BLK1
  16520  UT        REAL

 FILE NAMES        MODE
   6204  DTVA1                      0  INPUT                    2054  OUTPUT                    41
   4130  TAPE1                   6204  TAPE2                       0  TAPE5                     20
  10260  TAPE7                  12334  TAPE9

 EXTERNALS            TYPE   ARGS
         FRMLP1                24                           FRMLP2              26
         FRMLP3                27                           IN1                 11
         IN2                   15                           IN3                 20
         OUT                    7                           PLOT                 3
         PLOTS                  4                           PLTSQ               10
         PLT1                  11                           PRSCH               18
         QUAL                   6                           TRANS                5
         ZX3LP                 13

 STATEMENT LABELS
      0  1                                15762  2      FMT                    16061  3
  15764  5      FMT                       16131  6      FMT                    16160  7
  14654  8                                16165  9      FMT                        0  10
```

```
STATEMENT LABELS
    0  11                                    0  12                                   16150  13
    0  15                                    0  16                                   16217  17
16034  19      FMT                       16236  21      FMT                          16245  22
16364  25      FMT                           0  26                                       0  30
16320  35      FMT                       16271  41      FMT                          16276  42
16303  43      FMT                       16310  44      FMT                          16347  46
16354  47      FMT                       16414  48      FMT                          16421  49
15115  50

LOOPS   LABEL    INDEX     FROM-TO    LENGTH    PROPERTIES
14500   1        I          78 81       4B          OPT
14514   15       K          85 93      20B                NOT INNER
14524   16       J          88 90       3B          OPT
14544            I          99 99       4B                EXT REFS
14611   50       ICT       116 221    307B                EXT REFS  NOT INNER
14661   11       I         144 146     16B                EXT REFS
14703   10       K         148 167     50B                EXT REFS  NOT INNER
14716   12       J         155 161     13B          OPT
15024            I         192 192      4B                EXT REFS
15045   30       I         196 200      7B          OPT
15125            I         224 224      4B                EXT REFS
15175   26       I         242 246      7B          OPT
15210            I         247 247      4B                EXT REFS

COMMON BLOCKS   LENGTH
       BLK1        120

STATISTICS
  PROGRAM LENGTH               234044B   79908
  BUFFER LENGTH                 13557B    5999
  CM LABELED COMMON LENGTH        170B     120
        52000B CM USED
```

```
      SUBROUTINE IN1
     + (ICHR,ICHT,R1,R2,S,EPS,DEL,RGAM,RMEU,N,MD1)
C
C     THIS ROUTINE READS THE INPUT FILE AND PRINTS OUT A COPY OF THEM.
C
      READ (ICHR,5) IC
    5 FORMAT(A1)
      READ (ICHR,*) R1,R2,S,EPS,DEL
      PRINT (ICHT,7) R1,R2,S,EPS,DEL
    7 FORMAT(5X,"R1=",F8.2,2X,"R2=",F8.2,2X,"S=",F8.2,2X,
     + "EPS=",F5.3,5X,"DEL=",F5.3,5X)
      READ (ICHR,5) IC
      READ (ICHR,*) RGAM,RMEU
      PRINT (ICHT,8) RGAM,RMEU
    8 FORMAT(5X,"GAMMA=",F5.3,5X,"MEU=",F5.3)
      READ (ICHR,5) IC
      RETURN
      END
```

SYMBOLIC REFERENCE MAP (R=1)

```
ENTRY POINTS
    3  IN1

VARIABLES      SN  TYPE             RELOCATION
    0  DEL         REAL                  F.P.        0  EPS     REAL                F.P.
  115  IC          INTEGER                           0  ICHR    INTEGER             F.P.
    0  ICHT        INTEGER               F.P.        0  MD1     INTEGER   *UNUSED   F.P.
    0  N           INTEGER   *UNUSED     F.P.        0  RGAM    REAL                F.P.
    0  RMEU        REAL                  F.P.        0  R1      REAL                F.P.
    0  R2          REAL                  F.P.        0  S       REAL                F.P.

STATEMENT LABELS
   31  5       FMT                   53  7       FMT                 103  8

STATISTICS
  PROGRAM LENGTH              116B     78
        52000B CM USED
```

```
      SUBROUTINE IN2
     + (ICHR,ICHT,DT,R1,R2,S,EPS,DEL,RGAM,RMEU,N,UT,UL,UH,MD1)


C
C     THIS ROUTINE READS THE INPUT FILE AND PRINTS OUT A COPY OF THEM.
C

      READ (ICHR,5) IC
    5 FORMAT(A1)
      READ (ICHR,*) R1,R2,S,EPS,DEL
      PRINT (ICHT,7) R1,R2,S,EPS,DEL
    7 FORMAT(5X,"R1=",F8.2,2X,"R2=",F8.2,2X,"S=",F8.2,2X,
     + "EPS=",F5.3,5X,"DEL=",F5.3,5X)
      READ (ICHR,5) IC
      READ (ICHR,*) RGAM,RMEU
      PRINT (ICHT,6) RGAM,RMEU
    6 FORMAT(5X,"GAMMA=",F5.3,5X,"MEU=",F5.3)
      READ (ICHR,5) IC
      READ (ICHR,*) UT,UL,UH
      UL=UL*DT
      UH=UH*DT
      PRINT (ICHT,8) UT,UL,UH
    8 FORMAT(5X,"UT=",F8.2,2X,"UL=",F8.2,2X,"UH=",F8.2//)
      READ (ICHR,5) IC
      RETURN
      END
```

```
     SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  IN2

VARIABLES       SN  TYPE            RELOCATION
    0  DEL          REAL                 F.P.          0  DT        REAL                    F.P.
    0  EPS          REAL                 F.P.        155  IC        INTEGER
    0  ICHR         INTEGER              F.P.          0  ICHT      INTEGER                 F.P.
    0  MD1          INTEGER   *UNUSED    F.P.          0  N         INTEGER   *UNUSED       F.P.
    0  RGAM         REAL                 F.P.          0  RMEU      REAL                    F.P.
    0  R1           REAL                 F.P.          0  R2        REAL                    F.P.
    0  S            REAL                 F.P.          0  UH        REAL                    F.P.
    0  UL           REAL                 F.P.          0  UT        REAL                    F.P.

STATEMENT LABELS
   42  5        FMT                   114  6        FMT                          64  7
  142  8        FMT

STATISTICS
  PROGRAM LENGTH               156B      110
         52000B CM USED
```

```
      SUBROUTINE IN3
     + (ICHR,ICHT,
     + DT,R1,R2,S,BETA,EPS,DEL,RGAM,RMEU,N,UT,UL,UH,MD1)

C
C     THIS ROUTINE READS THE INPUT FILE AND PRINTS OUT A COPY OF THEM.
C

      READ (ICHR,5) IC
    5 FORMAT(A1)
      READ (ICHR,*) R1,R2,S,EPS,DEL
      PRINT (ICHT,7) R1,R2,S,EPS,DEL
    7 FORMAT(5X,"R1=",F8.2,2X,"R2=",F8.2,2X,"S=",F8.2,2X,
     + "EPS=",F5.3,5X,"DEL=",F5.3)
      READ (ICHR,5) IC
      READ (ICHR,*) BETA,RGAM,RMEU
      PRINT (ICHT,6) BETA,RGAM,RMEU
    6 FORMAT(5X,"BETA=",F5.3,5X,"GAMMA=",F5.3,5X,"MEU=",F5.3)
      READ (ICHR,5) IC
      READ (ICHR,*) UT,UL,UH
      UL=UL*DT
      UH=UH*DT
      PRINT (ICHT,8) UT,UL,UH
    8 FORMAT(5X,"UT=",F8.2,2X,"UL=",F8.2,2X,"UH=",F8.2//)
      READ (ICHR,5) IC
      RETURN
      END
```

SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
3 IN3

VARIABLES SN TYPE RELOCATION

0	BETA	REAL		F.P.	0	DEL	REAL		F.P.
0	DT	REAL		F.P.	0	EPS	REAL		F.P.
160	IC	INTEGER			0	ICHR	INTEGER		F.P.
0	ICHT	INTEGER		F.P.	0	MD1	INTEGER	*UNUSED	F.P.
0	N	INTEGER	*UNUSED	F.P.	0	RGAM	REAL		F.P.
0	RMEU	REAL		F.P.	0	R1	REAL		F.P.
0	R2	REAL		F.P.	0	S	REAL		F.P.
0	UH	REAL		F.P.	0	UL	REAL		F.P.
0	UT	REAL		F.P.					

STATEMENT LABELS

42	5	FMT	116	6	FMT	64	7	
145	8	FMT						

STATISTICS
PROGRAM LENGTH 161B 113
52000B CM USED

```
      SUBROUTINE FRMLP1(R1,R2,S,EPS,DEL,RGAM,RMEU,DT,N,P,Q,R,G,U,MD1,
     + A,B,C,C1,M1,M2,NP,MD2,MD3)

      REAL P(MD1),Q(MD1),R(MD1),G(MD1),U(MD1)
      REAL A(MD2,MD3),B(MD2),C(MD3),C1(MD3)

C
C     THIS ROUTINE FORMS THE OPERATING MATRICES FOR THE LINEAR
C     PROGRAMMING EXECUTION.
C

      M1=5*N-1
      M2=N+1
      NP=7*N+1

C     CLEAR A,B,C
      M3=M1+M2+2
      DO 2 I=1,M3
      B(I)=0
      DO 2 J=1,NP
      A(I,J)=0
    2 CONTINUE
      DO 3 J=1,NP
      C(J)=0
      C1(J)=0
    3 CONTINUE

C     M1 INEQUALITY CONSTRAINTS
      A(1,1)=1
      B(1)=S
      DO 30 K=1,N
      I1=3*(K-1)+1
      I2=7*(K-1)+1
      A(I1+1,I2+1)=EPS
      A(I1+1,I2+2)=EPS
      B(I1+1)=R1*DT

      A(I1+2,I2+2)=1
      A(I1+2,I2+3)=1.0/RGAM
      A(I1+2,I2+4)=1
      B(I1+2)=G(K)

      A(I1+3,I2+6)=1.0/DEL
      A(I1+3,I2+7)=1.0/DEL
      B(I1+3)=R2*DT
   30 CONTINUE

      TMEU1=1.0/RMEU
      N1=N-1
      DO 40 J=1,N1
      TMEU2=1.0/RMEU
      TMEU1=TMEU1*RMEU
      J1=2*(J-1)
      A(I1+J1+4,1)=TMEU1
      A(I1+J1+5,1)=-TMEU1
      B(I1+J1+4)=S
      B(I1+J1+5)=0
```

```
      DO 50 K1=1,J
      TMEU2=TMEU2*RMEU
      K=J-K1+1
      K2=7*(K-1)+1
      A(I1+J1+4,K2+1)=EPS*TMEU2
      IF (K.NE.J) A(I1+J1+5,K2+1)=-EPS*TMEU2
      A(I1+J1+4,K2+2)=EPS*TMEU2
      IF (K.NE.J) A(I1+J1+5,K2+2)=-EPS*TMEU2
      A(I1+J1+4,K2+6)=-TMEU2/DEL
      A(I1+J1+5,K2+6)=TMEU2/DEL
      A(I1+J1+4,K2+7)=-TMEU2/DEL
      A(I1+J1+5,K2+7)=TMEU2/DEL
   50 CONTINUE
   40 CONTINUE

C     M2 EQUALITY CONSTRAINTS

      DO 60 K=1,N
      I2=7*(K-1)+1
      A(M1+K,I2+4)=1
      A(M1+K,I2+5)=RGAM
      A(M1+K,I2+6)=1
      B(M1+K)=U(K)
   60 CONTINUE

      A(M1+N+1,1)=TMEU2*RMEU-1.0
      C(1)=-1.0E-8
      TMEU1=1.0/RMEU
      DO 70 K1=1,N
      TMEU1=TMEU1*RMEU
      K=N-K1+1
      I2=7*(K-1)+1
      A(M1+N+1,I2+1)=EPS*TMEU1
      A(M1+N+1,I2+2)=EPS*TMEU1
      A(M1+N+1,I2+6)=-TMEU1/DEL
      A(M1+N+1,I2+7)=-TMEU1/DEL
      C(I2+1)=-Q(K)
      C(I2+2)=-R(K)
      C(I2+3)=P(K)-R(K)/RGAM
      C(I2+4)=-R(K)
      C(I2+5)=-Q(K)
      C(I2+7)=P(K)

      C1(I2+1)=Q(K)
      C1(I2+3)=-P(K)
      C1(I2+5)=Q(K)
      C1(I2+7)=-P(K)

   70 CONTINUE
      B(M1+N+1)=0
      RETURN
      END
```

```
      SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  FRMLP1

VARIABLES      SN  TYPE          RELOCATION
    0  A          REAL      ARRAY     F.P.          0  B          REAL      ARRAY     F.P.
    0  C          REAL      ARRAY     F.P.          0  C1         REAL      ARRAY     F.P.
    0  DEL        REAL                F.P.          0  DT         REAL                F.P.
    0  EPS        REAL                F.P.          0  G          REAL      ARRAY     F.P.
  352  I          INTEGER                         355  I1         INTEGER
  356  I2         INTEGER                         353  J          INTEGER
  362  J1         INTEGER                         354  K          INTEGER
  363  K1         INTEGER                         364  K2         INTEGER
    0  MD1        INTEGER             F.P.          0  MD2        INTEGER             F.P.
    0  MD3        INTEGER             F.P.          0  M1         INTEGER             F.P.
    0  M2         INTEGER             F.P.        351  M3         INTEGER
    0  N          INTEGER             F.P.          0  NP         INTEGER             F.P.
  360  N1         INTEGER                           0  P          REAL      ARRAY     F.P.
    0  Q          REAL      ARRAY     F.P.          0  R          REAL      ARRAY     F.P.
    0  RGAM       REAL                F.P.          0  RMEU       REAL                F.P.
    0  R1         REAL                F.P.          0  R2         REAL                F.P.
    0  S          REAL                F.P.        357  TMEU1      REAL
  361  TMEU2      REAL                              0  U          REAL      ARRAY     F.P.

STATEMENT LABELS
    0  2                                  0  3                                     0  30
    0  40                                 0  50                                    0  60
    0  70

LOOPS  LABEL     INDEX     FROM-TO    LENGTH     PROPERTIES
   21  2         I         18  22       15B                  NOT INNER
   30  2         J         20  22        2B         OPT
   43  3         J         23  26        2B         OPT
  107  30        K         31  46       22B         OPT
  137  40        J         50  71       61B                  NOT INNER
  164  50        K1        58  70       30B         OPT
  241  60        K         75  81        7B         OPT
  300  70        K1        86  106      26B         OPT

STATISTICS
  PROGRAM LENGTH                 427B       279
        52000B CM USED
```

```
      SUBROUTINE FRMLP2
     + (R1,R2,S,EPS,DEL,RGAM,RMEU,DT,N,P,Q,R,G,UT,UL,UH,MD1,
     + A,B,C,C1,M1,M2,NP,MD2,MD3)

      REAL P(MD1),Q(MD1),R(MD1),G(MD1)
      REAL A(MD2,MD3),B(MD2),C(MD3),C1(MD3)

C
C     THIS ROUTINE FORMS THE OPERATING MATRICES FOR THE LINEAR
C     PROGRAMMING EXECUTION.
C

      M1=7*N-1
      M2=N+2
      NP=8*N+1

C     CLEAR A,B,C
      M3=M1+M2+2
      DO 2 I=1,M3
      B(I)=0
      DO 2 J=1,NP
      A(I,J)=0
    2 CONTINUE
      DO 3 J=1,NP
      C(J)=0
      C1(J)=0
    3 CONTINUE

C     M1 INEQUALITY CONSTRAINTS
      A(1,1)=1
      B(1)=S
      DO 30 K=1,N
      I1=5*(K-1)+1
      I2=8*(K-1)+1
      A(I1+1,I2+1)=EPS
      A(I1+1,I2+2)=EPS
      B(I1+1)=R1*DT

      A(I1+2,I2+2)=1
      A(I1+2,I2+3)=1.0/RGAM
      A(I1+2,I2+4)=1
      B(I1+2)=G(K)

      A(I1+3,I2+6)=1.0/DEL
      A(I1+3,I2+7)=1.0/DEL
      B(I1+3)=R2*DT

      A(I1+4,I2+8)=1
      B(I1+4)=UH

      A(I1+5,I2+8)=-1
      B(I1+5)=-UL
   30 CONTINUE
      M4=5*N+1

      TMEU1=1.0/RMEU
      N1=N-1
```

```
              DO 40 J=1,N1
              TMEU2=1.0/RMEU
              TMEU1=TMEU1*RMEU
              J1=2*(J-1)
              A(M4+J1+1,1)=TMEU1
              A(M4+J1+2,1)=-TMEU1
              B(M4+J1+1)=S
              B(M4+J1+2)=0
              DO 50 K1=1,J
              TMEU2=TMEU2*RMEU
              K=J-K1+1
              K2=8*(K-1)+1
              A(M4+J1+1,K2+1)=EPS*TMEU2
              IF(K.NE.J) A(M4+J1+2,K2+1)=-EPS*TMEU2
              A(M4+J1+1,K2+2)=EPS*TMEU2
              IF(K.NE.J) A(M4+J1+2,K2+2)=-EPS*TMEU2
              A(M4+J1+1,K2+6)=-TMEU2/DEL
              A(M4+J1+2,K2+6)=TMEU2/DEL
              A(M4+J1+1,K2+7)=-TMEU2/DEL
              A(M4+J1+2,K2+7)=TMEU2/DEL
        50    CONTINUE
        40    CONTINUE

      C       M2 EQUALITY CONSTRAINTS

              DO 60 K=1,N
              I2=8*(K-1)+1
              A(M1+K,I2+4)=1
              A(M1+K,I2+5)=RGAM
              A(M1+K,I2+6)=1
              A(M1+K,I2+8)=-1
        60    CONTINUE

              A(M1+N+1,1)=TMEU2*RMEU-1.0
              C(1)=-1.0E-8
              TMEU1=1.0/RMEU
              DO 70 K1=1,N
              TMEU1=TMEU1*RMEU
              K=N-K1+1
              I2=8*(K-1)+1
              A(M1+N+1,I2+1)=EPS*TMEU1
              A(M1+N+1,I2+2)=EPS*TMEU1
              A(M1+N+1,I2+6)=-TMEU1/DEL
              A(M1+N+1,I2+7)=-TMEU1/DEL
              A(M1+N+2,I2+8)=1

              C(I2+1)=-Q(K)
              C(I2+2)=-R(K)
              C(I2+3)=P(K)-R(K)/RGAM
              C(I2+4)=-R(K)
              C(I2+5)=-Q(K)
              C(I2+7)=P(K)

              C1(I2+1)=Q(K)
              C1(I2+3)=-P(K)
              C1(I2+5)=Q(K)
              C1(I2+7)=-P(K)
```

```
                  70    CONTINUE
                        B(M1+N+1)=0
                        B(M1+N+2)=UT
                        RETURN
                        END
```

SYMBOLIC REFERENCE MAP (R=1)

```
ENTRY POINTS
    3  FRMLP2

VARIABLES       SN   TYPE              RELOCATION
    0  A            REAL       ARRAY      F.P.              0  B          REAL       ARRAY      F.P.
    0  C            REAL       ARRAY      F.P.              0  C1         REAL       ARRAY      F.P.
    0  DEL          REAL                  F.P.              0  DT         REAL                  F.P.
    0  EPS          REAL                  F.P.              0  G          REAL       ARRAY      F.P.
  400  I            INTEGER                               403  I1         INTEGER
  404  I2           INTEGER                               401  J          INTEGER
  411  J1           INTEGER                               402  K          INTEGER
  412  K1           INTEGER                               413  K2         INTEGER
    0  MD1          INTEGER               F.P.              0  MD2        INTEGER               F.P.
    0  MD3          INTEGER               F.P.              0  M1         INTEGER               F.P.
    0  M2           INTEGER               F.P.            377  M3         INTEGER
  405  M4           INTEGER                                 0  N          INTEGER               F.P.
    0  NP           INTEGER               F.P.            407  N1         INTEGER
    0  P            REAL       ARRAY      F.P.              0  Q          REAL       ARRAY      F.P.
    0  R            REAL       ARRAY      F.P.              0  RGAM       REAL                  F.P.
    0  RMEU         REAL                  F.P.              0  R1         REAL                  F.P.
    0  R2           REAL                  F.P.              0  S          REAL                  F.P.
  406  TMEU1        REAL                                  410  TMEU2      REAL
    0  UH           REAL                  F.P.              0  UL         REAL                  F.P.
    0  UT           REAL                  F.P.

STATEMENT LABELS
    0  2                               0  3                                    0  30
    0  40                              0  50                                   0  60
    0  70

LOOPS  LABEL    INDEX      FROM-TO    LENGTH    PROPERTIES
   20  2        I            19 23       15B              NOT INNER
   27  2        J            21 23        2B        OPT
   42  3        J            24 27        2B        OPT
  113  30       K            32 53       27B        OPT
  151  40       J            58 79       61B              NOT INNER
  176  50       K1           66 78       30B        OPT
  255  60       K            83 89        7B        OPT
  320  70       K1           94 116      30B        OPT

STATISTICS
  PROGRAM LENGTH                 457B      303
        52000B CM USED
```

```
      SUBROUTINE FRMLP3
     + (R1,R2,S,BETA,EPS,DEL,RGAM,RMEU,DT,N,P,Q,R,G,UT,UL,UH,MD1,
     + A,B,C,C1,M1,M2,NP,MD2,MD3)

      REAL P(MD1),Q(MD1),R(MD1),G(MD1)
      REAL A(MD2,MD3),B(MD2),C(MD3),C1(MD3)

C
C     THIS ROUTINE FORMS THE OPERATING MATRICES FOR THE LINEAR
C     PROGRAMMING EXECUTION.
C

      M1=7*N-1
      M2=2*N+2
      NP=10*N+1

C     CLEAR A,B,C
      M3=M1+M2+2
      DO 2 I=1,M3
      B(I)=0
      DO 2 J=1,NP
      A(I,J)=0
    2 CONTINUE
      DO 3 J=1,NP
      C(J)=0
      C1(J)=0
    3 CONTINUE

C     M1 INEQUALITY CONSTRAINTS
      A(1,1)=1
      B(1)=S
      DO 30 K=1,N
      I1=5*(K-1)+1
      I2=10*(K-1)+1
      A(I1+1,I2+1)=EPS
      A(I1+1,I2+2)=EPS
      A(I1+1,I2+9)=EPS
      B(I1+1)=R1*DT

      A(I1+2,I2+2)=1
      A(I1+2,I2+3)=1.0/RGAM
      A(I1+2,I2+4)=1
      B(I1+2)=G(K)

      A(I1+3,I2+6)=1.0/DEL
      A(I1+3,I2+7)=1.0/DEL
      B(I1+3)=R2*DT

      A(I1+4,I2+8)=1
      B(I1+4)=UH

      A(I1+5,I2+8)=-1
      B(I1+5)=-UL
   30 CONTINUE
      M4=5*N+1

      TMEU1=1.0/RMEU
```

```
      N1=N-1
      DO 40 J=1,N1
      TMEU2=1.0/RMEU
      TMEU1=TMEU1*RMEU
      J1=2*(J-1)
      A(M4+J1+1,1)=TMEU1
      A(M4+J1+2,1)=-TMEU1
      B(M4+J1+1)=S
      B(M4+J1+2)=0
      DO 50 K1=1,J
      TMEU2=TMEU2*RMEU
      K=J-K1+1
      K2=10*(K-1)+1
      A(M4+J1+1,K2+1)=EPS*TMEU2
      IF(K.NE.J) A(M4+J1+2,K2+1)=-EPS*TMEU2
      A(M4+J1+1,K2+2)=EPS*TMEU2
      IF(K.NE.J) A(M4+J1+2,K2+2)=-EPS*TMEU2
      A(M4+J1+1,K2+9)=EPS*TMEU2
      IF(K.NE.J) A(M4+J1+2,K2+9)=-EPS*TMEU2
      A(M4+J1+1,K2+6)=-TMEU2/DEL
      A(M4+J1+2,K2+6)=TMEU2/DEL
      A(M4+J1+1,K2+7)=-TMEU2/DEL
      A(M4+J1+2,K2+7)=TMEU2/DEL
   50 CONTINUE
   40 CONTINUE

C     M2 EQUALITY CONSTRAINTS

      DO 60 K=1,N
      I2=10*(K-1)+1
      A(M1+K,I2+4)=1
      A(M1+K,I2+5)=RGAM
      A(M1+K,I2+6)=1
      A(M1+K,I2+8)=-1
      A(M1+N+K,I2+9)=1
      A(M1+N+K,I2+10)=1.0/RGAM
      A(M1+N+K,I2+8)=-BETA
   60 CONTINUE

      A(M1+2*N+1,1)=TMEU2*RMEU-1.0
      C(1)=-1.0E-8
      TMEU1=1.0/RMEU
      DO 70 K1=1,N
      TMEU1=TMEU1*RMEU
      K=N-K1+1
      I2=10*(K-1)+1
      A(M1+2*N+1,I2+1)=EPS*TMEU1
      A(M1+2*N+1,I2+2)=EPS*TMEU1
      A(M1+2*N+1,I2+9)=EPS*TMEU1
      A(M1+2*N+1,I2+6)=-TMEU1/DEL
      A(M1+2*N+1,I2+7)=-TMEU1/DEL
      A(M1+2*N+2,I2+8)=1

      C(I2+1)=-Q(K)
      C(I2+2)=-R(K)
      C(I2+3)=P(K)-R(K)/RGAM
      C(I2+4)=-R(K)
```

```
                  C(I2+5)=-Q(K)
                  C(I2+7)=P(K)
                  C(I2+10)=P(K)

                  C1(I2+1)=Q(K)
                  C1(I2+3)=-P(K)
                  C1(I2+5)=Q(K)
                  C1(I2+7)=-P(K)
                  C1(I2+10)=-P(K)

           70     CONTINUE
                  B(M1+2*N+2)=UT
                  RETURN
                  END
```

SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
3 FRMLP3

VARIABLES SN		TYPE		RELOCATION	SN		TYPE		RELOCATION
0	A	REAL	ARRAY	F.P.	0	B	REAL	ARRAY	F.P.
0	BETA	REAL		F.P.	0	C	REAL	ARRAY	F.P.
0	C1	REAL	ARRAY	F.P.	0	DEL	REAL		F.P.
0	DT	REAL		F.P.	0	EPS	REAL		F.P.
0	G	REAL	ARRAY	F.P.	464	I	INTEGER		
467	I1	INTEGER			470	I2	INTEGER		
465	J	INTEGER			475	J1	INTEGER		
466	K	INTEGER			476	K1	INTEGER		
477	K2	INTEGER			0	MD1	INTEGER		F.P.
0	MD2	INTEGER		F.P.	0	MD3	INTEGER		F.P.
0	M1	INTEGER		F.P.	0	M2	INTEGER		F.P.
463	M3	INTEGER			471	M4	INTEGER		
0	N	INTEGER		F.P.	0	NP	INTEGER		F.P.
473	N1	INTEGER			0	P	REAL	ARRAY	F.P.
0	Q	REAL	ARRAY	F.P.	0	R	REAL	ARRAY	F.P.
0	RGAM	REAL		F.P.	0	RMEU	REAL		F.P.
0	R1	REAL		F.P.	0	R2	REAL		F.P.
0	S	REAL		F.P.	472	TMEU1	REAL		
474	TMEU2	REAL			0	UH	REAL		F.P.
0	UL	REAL		F.P.	0	UT	REAL		F.P.

STATEMENT LABELS

0	2	0	3	0	30
0	40	0	50	0	60
0	70				

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
21	2	I	19 23	15B	NOT INNER
30	2	J	21 23	2B	OPT
43	3	J	24 27	2B	OPT
116	30	K	32 54	32B	OPT
157	40	J	59 82	73B	NOT INNER

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
206	50	K1	67 81	40B	OPT
320	60	K	86 95	16B	OPT
377	70	K1	100 125	33B	OPT

STATISTICS

```
  PROGRAM LENGTH                    552B      362
          52000B CM USED
```

```
      SUBROUTINE OUT(ICHT,IOPT,PSOL,N,SMAX,IER,MD3)
      REAL PSOL(MD3)
C
C     THIS ROUTINE OUTPUTS THE RESULTS OF THE OPTIMUM SPOT PRICING
C     PROCEDURE.
C
      IF((IOPT.EQ.1).OR.(IOPT.EQ.2)) ISOE=7
      IF((IOPT.EQ.3).OR.(IOPT.EQ.4)) ISOE=8
      IF((IOPT.EQ.5).OR.(IOPT.EQ.6)) ISOE=10
      PRINT (ICHT,5)
    5 FORMAT("1")
      PRINT (ICHT,7) PSOL(1),SMAX,IER
    7 FORMAT(10X,"XO=",F8.2,8X,"REVENUE=",F10.2,8X,"ERROR=",I5/)
      PRINT (ICHT,12) (I,I=1,ISOE)
   12 FORMAT(8X,"    K     ",10(I5,5X))
      PRINT (ICHT,14)
   14 FORMAT(4X,"PERIOD")
      DO 10 K=1,N
      I2=ISOE*(K-1)+1
      PRINT (ICHT,15) K,(PSOL(I2+I),I=1,ISOE)
   15 FORMAT(7X,I3,5X,10(F8.2,2X))
   10 CONTINUE
      RETURN
      END
```

SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
3 OUT

VARIABLES		SN	TYPE	RELOCATION					
147	I		INTEGER		0	ICHT	INTEGER		F.P.
0	IER		INTEGER	F.P.	0	IOPT	INTEGER		F.P.
146	ISOE		INTEGER		151	I2	INTEGER		
150	K		INTEGER		0	MD3	INTEGER		F.P.
0	N		INTEGER	F.P.	0	PSOL	REAL	ARRAY	F.P.
0	SMAX		REAL	F.P.					

STATEMENT LABELS

75	5	FMT	105	7	FMT	0	10
122	12	FMT	131	14	FMT	143	15

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
37		I	17 17	4B	EXT REFS
47	10	K	21 25	22B	EXT REFS NOT INNER
55		I	23 23	10B	EXT REFS

STATISTICS
PROGRAM LENGTH 155B 109
52000B CM USED

```
      SUBROUTINE PRSCH
     + (ICHT,IOPT
     + ,P,Q,R,U,PSOL,SCH,N,SMAX,COST,BETA,EPS,DEL,RGAM,RMEU,MD1,MD3)

      REAL P(MD1),Q(MD1),R(MD1),U(MD1),PSOL(MD3)
      REAL SCH(MD1)

C
C     THIS ROUTINE PRINTS OUT THE OPTIMAL OPERATING SCHEDULE
C

      PRINT (ICHT,5)
    5 FORMAT("1")
      IF((IOPT.EQ.1).OR.(IOPT.EQ.3).OR.(IOPT.EQ.5)) PRINT (ICHT,10)
      IF((IOPT.EQ.2).OR.(IOPT.EQ.4).OR.(IOPT.EQ.6)) PRINT (ICHT,11)
   10 FORMAT(5X,"** OPTIMAL SCHEDULE FOR THE PRODUCER **"/)
   11 FORMAT(5X,"** OPTIMAL SCHEDULE FOR THE UTILITY **"/)
      PRINT (ICHT,12) PSOL(1)
   12 FORMAT(5X,"INITIAL STORAGE ENERGY LEVEL=",F8.2//)
      PRINT (ICHT,15)
   15 FORMAT
     +(7X,"PRODUCE",3X,"DEP-GEN",6X,"USE",7X,"SELL",6X," BUY",5X,"STORE"
     + ,6X,"LEVEL",5X,"LOSS",4X,"PROFIT")
      PRINT (ICHT,17)
   17 FORMAT(2X,"PERIOD")

      IF((IOPT.EQ.1).OR.(IOPT.EQ.2)) ISOE=7
      IF((IOPT.EQ.3).OR.(IOPT.EQ.4)) ISOE=8
      IF((IOPT.EQ.5).OR.(IOPT.EQ.6)) ISOE=10
      IF((ISOE.EQ.7).OR.(ISOE.EQ.8)) BETA=0.

      COST=0
      STORED=PSOL(1)
      DO 20 K=1,N
      I2=ISOE*(K-1)+1
      PRODUCE=PSOL(I2+2)+PSOL(I2+3)/RGAM+PSOL(I2+4)
      USE=PSOL(I2+4)+RGAM*PSOL(I2+5)+PSOL(I2+6)
      COGEN=BETA*USE
      IF((IOPT.EQ.3).OR.(IOPT.EQ.4)) U(K)=USE
      IF((IOPT.EQ.5).OR.(IOPT.EQ.6)) U(K)=USE
      STR=0
      DSC=0
      IF((IOPT.EQ.5).OR.(IOPT.EQ.6)) STR=PSOL(I2+9)
      IF((IOPT.EQ.5).OR.(IOPT.EQ.6)) DSC=PSOL(I2+10)
      SELL=PSOL(I2+3)+PSOL(I2+7)+DSC
      BUY=PSOL(I2+1)+PSOL(I2+5)
C     SCH(K)=SELL-BUY
      SCH(K)=BUY-SELL
      STORE=
     +EPS*(PSOL(I2+1)+PSOL(I2+2)+STR)-(PSOL(I2+6)+PSOL(I2+7))/DEL
      STORED=STORED*RMEU+STORE
      RLOSS=(1-EPS)*(PSOL(I2+1)+PSOL(I2+2)+STR)
     + +(1-DEL)*(PSOL(I2+6)+PSOL(I2+7))/DEL
     + +(1-RGAM)*(PSOL(I2+3)/RGAM+PSOL(I2+5))
      PROFIT=SELL*P(K)-BUY*Q(K)-PRODUCE*R(K)
      COST=COST+SELL*P(K)-BUY*Q(K)
      PRINT (ICHT,25)
```

```
             + K,PRODUCE,COGEN,USE,SELL,BUY,STORE,STORED,RLOSS,PROFIT
          25   FORMAT(2X,I2,2X,8(F8.2,2X),F12.2)
          20   CONTINUE
         C     PRINT (ICHT,30) SMAX,COST
         C30   FORMAT(5X,"NET REVENUE FOR SPPF = ",F10.2
         C   + /5X,"COST TO UTILITY = ",F10.2)
               IF (SMAX.GE.0.) PRINT (ICHT,31) SMAX
               IF (SMAX.LE.0.) PRINT (ICHT,32) -SMAX
               IF (COST.GE.0.) PRINT (ICHT,33) COST
               IF (COST.LE.0.) PRINT (ICHT,34) -COST
          31   FORMAT(/5X,"NET REVENUE FOR SPPF =",F15.2)
          32   FORMAT(/5X,"NET COST FOR SPPF =",F15.2)
          33   FORMAT(5X,"NET COST FOR UTILITY =",F15.2)
          34   FORMAT(5X,"NET REVENUE FOR UTILITY =",F15.2)
               RETURN
               END
```

```
    SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
   3  PRSCH

VARIABLES       SN  TYPE             RELOCATION
   0  BETA        REAL                    F.P.         412  BUY       REAL
 406  COGEN       REAL                                   0  COST      REAL               F.P.
   0  DEL         REAL                    F.P.         410  DSC       REAL
   0  EPS         REAL                    F.P.           0  ICHT      INTEGER            F.P.
   0  IOPT        INTEGER                 F.P.         400  ISOE      INTEGER
 403  I2          INTEGER                              402  K         INTEGER
   0  MD1         INTEGER                 F.P.           0  MD3       INTEGER            F.P.
   0  N           INTEGER                 F.P.           0  P         REAL      ARRAY    F.P.
 404  PRODUCE     REAL                                 415  PROFIT    REAL
   0  PSOL        REAL        ARRAY       F.P.           0  Q         REAL      ARRAY    F.P.
   0  R           REAL        ARRAY       F.P.           0  RGAM      REAL               F.P.
 414  RLOSS       REAL                                   0  RMEU      REAL               F.P.
   0  SCH         REAL        ARRAY       F.P.         411  SELL      REAL
   0  SMAX        REAL                    F.P.         413  STORE     REAL
 401  STORED      REAL                                 407  STR       REAL
   0  U           REAL        ARRAY       F.P.         405  USE       REAL

STATEMENT LABELS
 227  5      FMT                 237  10    FMT                      245  11
 257  12     FMT                 270  15    FMT                      307  17
   0  20                         327  25    FMT                      353  31
 360  32     FMT                 365  33    FMT                      372  34

LOOPS  LABEL   INDEX     FROM-TO    LENGTH    PROPERTIES
   71  20      K           34 60     111B               EXT REFS

STATISTICS
  PROGRAM LENGTH               445B     293
        52000B CM USED
```

```
                SUBROUTINE PLTSQ(XP,YP,XL,YL,FAC,COST,DT,ICOMM1,ICOMM2,ICOMM3)
C
C       THIS ROUTINE PLOTS A SQUARE AND PRINTS THE COMMENT.
C
        CALL FACTOR(FAC)
C       CALL PLOT(XP,YP,-3)
        CALL PLOT(0.,YL,-2)
        CALL PLOT(XL,0.,-2)
        CALL PLOT(0.,-YL,-2)
        CALL PLOT(-XL,0.,-2)
        CALL SYMBOL(1.,YL-1.,.225,ICOMM1,0.,10)
        CALL SYMBOL(3.,YL-1.,.225,ICOMM2,0.,10)
        CALL SYMBOL(5.,YL-1.,.225,ICOMM3,0.,10)
        CALL SYMBOL(1.,YL-1.5,.225,"DT = ",0.,5)
        CALL NUMBER(2.,YL-1.5,.225,DT,0.,2)
        IF(COST.GE.0.)
     +  CALL SYMBOL(1.,YL-2.,.225,"COST = $",0.,8)
        IF(COST.LE.0.)
     +  CALL SYMBOL(1.,YL-2.,.225,"REVENUE = $",0.,11)
        IF(COST.GE.0.)
     +  CALL NUMBER(4.,YL-2.,.225,COST,0.,2)
        IF(COST.LE.0.)
     +  CALL NUMBER(4.,YL-2.,.225,-COST,0.,2)
        RETURN
        END
```

```
       SYMBOLIC REFERENCE MAP  (R=1)

ENTRY POINTS
    3  PLTSQ

VARIABLES      SN  TYPE          RELOCATION
    0  COST       REAL               F.P.        0  DT        REAL                 F.P.
    0  FAC        REAL               F.P.        0  ICOMM1    INTEGER              F.P.
    0  ICOMM2     INTEGER            F.P.        0  ICOMM3    INTEGER              F.P.
    0  XL         REAL               F.P.        0  XP        REAL     *UNUSED     F.P.
    0  YL         REAL               F.P.        0  YP        REAL     *UNUSED     F.P.

EXTERNALS          TYPE   ARGS
       FACTOR               1                       NUMBER             6
       PLOT                 3                       SYMBOL             6

STATISTICS
  PROGRAM LENGTH                 261B      177
        52000B CM USED
```

```
      SUBROUTINE PLT1(A,OX,OY,DT,N,FAC,IX,JY,I1,J1,MD1)

      REAL A(MD1),XA(512),YA(512)
      REAL IX(2),JY(2)

C
C     THIS ROUTINE PLOTS THE NUMBERS IN THE ARRAY A.
C

      CALL PLOT(OX,OY,-3)
      CALL PLOT(0.,-.5,3)
      CALL FACTOR(FAC)

      N1=N-1
      N2=2*N
      DTC=0.
      XA(1)=0.
      YA(1)=A(1)
      DO 10 I=1,N1
      DTC=DTC+DT
      XA(2*I)=DTC
      XA(2*I+1)=DTC
      YA(2*I)=A(I)
      YA(2*I+1)=A(I+1)
   10 CONTINUE
      XA(N2)=N*DT
      YA(N2)=A(N)

      CALL SCALE(XA,6.5,N2,1)
      CALL SCALE(YA,4.5,N2,1)
      CALL AXIS(0.,0.,IX,-I1,6.5,0.,XA(N2+1),XA(N2+2))
      CALL AXIS(0.,0.,JY,J1,4.5,90.,YA(N2+1),YA(N2+2))
      CALL LINE(XA,YA,N2,1,0,0)
      CALL PLOT(-OX,-OY,-3)

      RETURN
      END
```

SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
3 PLT1

VARIABLES		SN TYPE	RELOCATION						
0	A	REAL	ARRAY	F.P.	0	DT	REAL		F.P.
177	DTC	REAL			0	FAC	REAL		F.P.
200	I	INTEGER			0	IX	REAL	ARRAY	F.P.
0	I1	INTEGER		F.P.	0	JY	REAL	ARRAY	F.P.
0	J1	INTEGER		F.P.	0	MD1	INTEGER		F.P.
0	N	INTEGER		F.P.	175	N1	INTEGER		
176	N2	INTEGER			0	OX	REAL		F.P.
0	OY	REAL		F.P.	201	XA	REAL	ARRAY	
1201	YA	REAL	ARRAY						

```
      SUBROUTINE PLT1        74/835  OPT=1                                  FTN 4.8+628          85/06

EXTERNALS           TYPE    ARGS
      AXIS                   8                          FACTOR               1
      LINE                   6                          PLOT                 3
      SCALE                  4

STATEMENT LABELS
    0  10

LOOPS  LABEL     INDEX     FROM-TO    LENGTH    PROPERTIES
   33  10        I           19 25        6B        OPT

STATISTICS
  PROGRAM LENGTH                 2203B    1155
        52000B CM USED
```

```
      SUBROUTINE IN11
     + (ICHT,IOPT,DT,R1,R2,S,EPS,DEL,RGAM,RMEU,N,P,Q,R,G,U,MD1)

      REAL P(MD1),Q(MD1),R(MD1),G(MD1),U(MD1)

C
C     THIS ROUTINE OUTPUTS THE FINAL PRICES AND OTHER INFORMATION.
C

C     PRINT (ICHT,2)
C2    FORMAT ("1")
      IC="C"
      PRINT (ICHT,5) IC
 5    FORMAT(A1)
      PRINT (ICHT,*) IOPT,DT,N
C     PRINT (ICHT,6) IOPT,DT,N
C6    FORMAT(5X,"IOPT=",I2,5X,"DT=",F8.2,2X,"N=",I5/)
      PRINT (ICHT,5) IC
      PRINT (ICHT,*) R1,R2,S,EPS,DEL
C     PRINT (ICHT,7) R1,R2,S,EPS,DEL
C7    FORMAT(5X,"R1=",F8.2,2X,"R2=",F8.2,2X,"S=",F8.2,2X,
C    + "EPS=",F5.3,5X,"DEL=",F5.3,5X)
      PRINT (ICHT,5) IC
      PRINT (ICHT,*) RGAM,RMEU
C     PRINT (ICHT,8) RGAM,RMEU
C8    FORMAT(5X,"GAMMA=",F5.3,5X,"MEU=",F5.3/)
      PRINT (ICHT,5) IC .
C     PRINT (ICHT,9)
C9    FORMAT(9X,"K",4X,"P(K)",6X,"Q(K)",6X,"R(K)",8X,"G(K)",6X,"U(K)")
      DO 10 K=1,N
      PRINT (ICHT,*) K,P(K),Q(K),R(K),G(K),U(K)
C     PRINT (ICHT,15) K,P(K),Q(K),R(K),G(K),U(K)
C15   FORMAT(5X,I5,3(F8.4,2X),2(F10.2))
 10   CONTINUE
      PRINT (ICHT,5) IC
      RETURN
      END
```

SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
3 IN11

VARIABLES SN		TYPE		RELOCATION					
0	DEL	REAL		F.P.	0	DT	REAL		F.P.
0	EPS	REAL		F.P.	0	G	REAL	ARRAY	F.P.
125	IC	INTEGER			0	ICHT	INTEGER		F.P.
0	IOPT	INTEGER		F.P.	126	K	INTEGER		
0	MD1	INTEGER		F.P.	0	N	INTEGER		F.P.
0	P	REAL	ARRAY	F.P.	0	Q	REAL	ARRAY	F.P.
0	R	REAL	ARRAY	F.P.	0	RGAM	REAL		F.P.
0	RMEU	REAL		F.P.	0	R1	REAL		F.P.
0	R2	REAL		F.P.	0	S	REAL		F.P.

```
      SUBROUTINE IN11         74/835   OPT=1                                       FTN 4.8+628         85/06

VARIABLES       SN   TYPE            RELOCATION
    0  U           REAL         ARRAY       F.P.

STATEMENT LABELS
   52  5         FMT                             0  10

LOOPS  LABEL      INDEX       FROM-TO     LENGTH     PROPERTIES
   26  10         K             30 34        15B                  EXT REFS

STATISTICS
  PROGRAM LENGTH                  136B        94
          52000B CM USED
```

```
      SUBROUTINE QUAL(ICHW,SCH,QF1,QF2,N,MD1)
C     THIS ROUTINE COMPUTES THE QUALITY FACTORS
      REAL SCH(MD1)
      QT=0
      QH=SCH(1)
      QL=SCH(1)
      DO 10 I=1,N
      QT=QT+SCH(I)
      IF(QH.LT.SCH(I)) QH=SCH(I)
      IF(QL.GT.SCH(I)) QL=SCH(I)
   10 CONTINUE
      IF (ABS(QL).LE.(1.0E-8)) PRINT *," TOO LOW!"
      IF (ABS(QL).LE.(1.0E-8)) RETURN
      QF1=QH/QL
C     QF2=QH*N/QT
      QF2=QT/(QH*N)
      PRINT (ICHW,20) QF1,QF2
   20 FORMAT(/5X,"THE QUALITY FACTORS ARE:"/5X,"QF1 = ",F7.4
     + ,5X,"QF2 = ",F7.4/)
      RETURN
      END
```

```
       SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  QUAL

VARIABLES      SN  TYPE           RELOCATION
   70  I           INTEGER                              0  ICHW      INTEGER             F.P.
    0  MD1         INTEGER             F.P.             0  N         INTEGER             F.P.
    0  QF1         REAL                F.P.             0  QF2       REAL                F.P.
   66  QH          REAL                                67  QL        REAL
   65  QT          REAL                                 0  SCH       REAL       ARRAY    F.P.

FILE NAMES         MODE
       OUTPUT      FREE

INLINE FUNCTIONS    TYPE    ARGS
       ABS          REAL      1  INTRIN

STATEMENT LABELS
    0  10                                 54  20      FMT

LOOPS  LABEL    INDEX     FROM-TO    LENGTH     PROPERTIES
   14  10       I            7 11       10B         OPT

STATISTICS
  PROGRAM LENGTH                   73B      59
        52000B CM USED
```

```
                  SUBROUTINE TRANS(SCH,SCHW,DT,N,MD1)
                  REAL SCH(MD1),SCHW(MD1)
                  DO 10 I=1,N
                  SCHW(I)=SCH(I)/DT
             10   CONTINUE
                  RETURN
                  END
```

```
    SYMBOLIC REFERENCE MAP  (R=1)

ENTRY POINTS
    3  TRANS

VARIABLES      SN  TYPE            RELOCATION
    0  DT         REAL                 F.P.           17  I          INTEGER
    0  MD1        INTEGER              F.P.            0  N          INTEGER               F.P.
    0  SCH        REAL       ARRAY     F.P.            0  SCHW       REAL       ARRAY      F.P.

STATEMENT LABELS
    0  10

LOOPS  LABEL     INDEX      FROM-TO     LENGTH     PROPERTIES
   13  10        I             3 5          3B         OPT

STATISTICS
  PROGRAM LENGTH                   22B        18
          52000B CM USED
```

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DATE: 11 JUN 85 AT 16:49:38

DEPARTMENT: DFAULT:JDL*

JOB ID: 908 REPORT NO. 23

FILE ID:

INPUT PROCESSING TIME: 00:00:23

OUTPUT PROCESSING TIME: 00:01:34

REPORT COMPLETION CODE: 50

PAGES TO BIN:	35		
PAGES TO TRAY:	0		
PAPER PATH HOLES:	10		
LINES PRINTED:	1586	GRAPHIC PAGES PRINTED:	1
ONLINE IDLE (SEC):	0	GRAPHIC EXCEPTION CODE:	0
BLOCKS READ:	0	GRAPHIC IMAGES READ:	0
BLOCKS SKIPPED:	0	GRAPHIC IMAGES MOVED:	0
RECORDS READ:	1591		
DJDE RECORDS READ:	9		
MAXIMUM COPY COUNT:	1		
OVERPRINTS:	0		
COLLATE:	YES		
SF/MF:	MULTI		
SIMPLEX/DUPLEX:	BOTH		

JDE.JDL USED: DFLT.DFAULT

ACCTINFO:

INITIAL FONT LIST: L0112B

(DJDE MODIFIED)

INITIAL FORM LIST: BANNER

(DJDE MODIFIED)

INITIAL CME LIST: -NONE

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